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ROLLING DAMS AT SCHWEINFURT, BAVARIA.

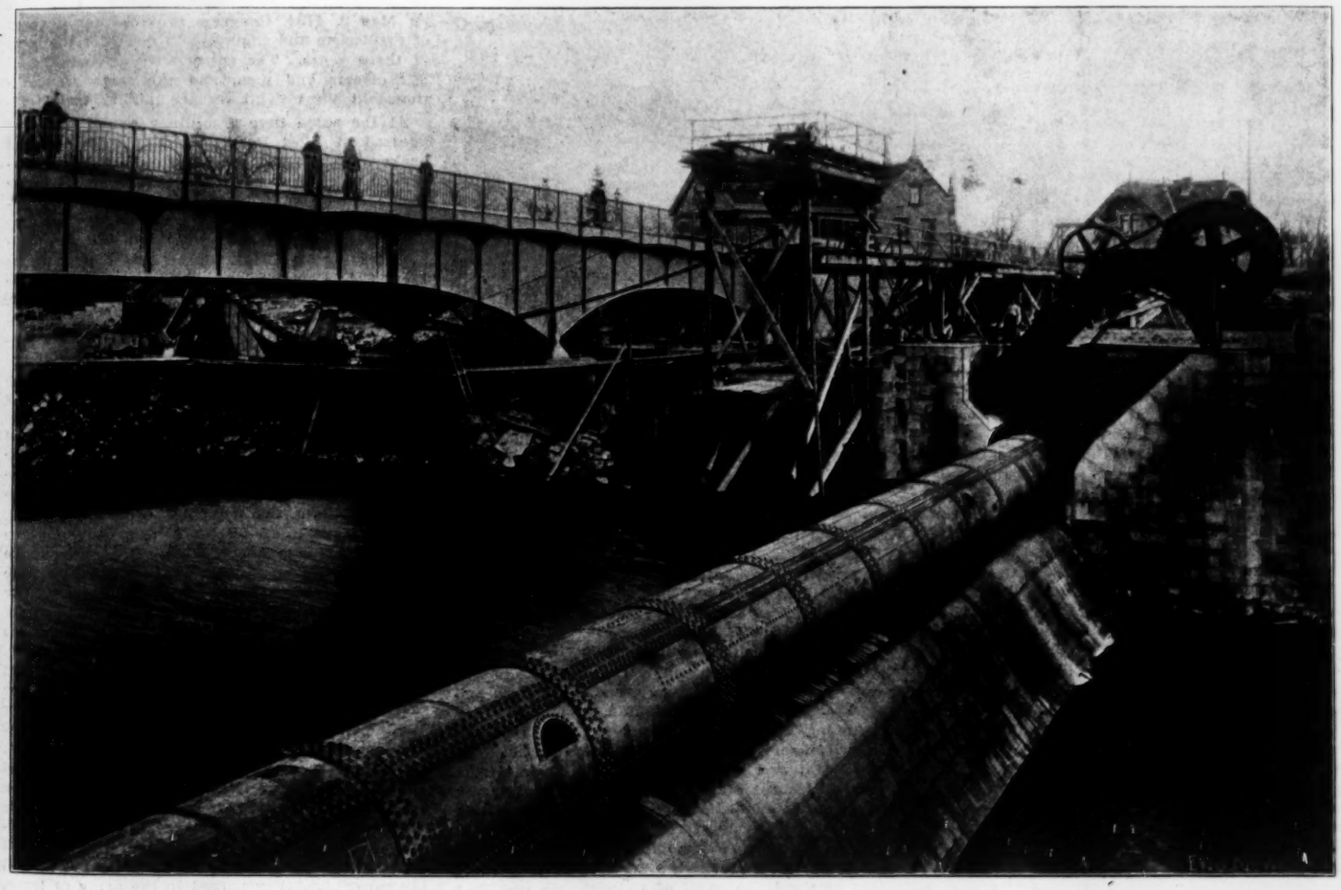
By Emile Guarini.*

Two very interesting movable dams have lately been constructed at Schweinfurt, by the Brückenbauanstalt Co. of Nürnberg. They were built partly to render the stream above them navigable and partly to divert the water for power utilization. The first dam was constructed across a secondary branch of the river at Schweinfurt, with a total length of 59 ft. and a diameter of 13.58 ft. The satisfactory operation of this construction led to the construction across the main branch of the dam shown in the engraving. This is 121.3 ft. long and 6.56 ft. in diameter.

The larger dam was begun in May, 1903, and was put in service in the following December. Its actual length is 121.3 ft. The dam consists of a hollow cylinder of steel plate, on each end of which is fixed a toothed wheel which meshes with an inclined rack built in each abutment. The dam as a whole consists first of a sill upon which the cylinder in its lowermost position rests. The steel is 1.1 in. thick, built in sections 9.84 ft. long, with a single longitudinal joint. The transverse joints are butt joints. Each section is reinforced in the middle by a brace, contributing to its rigidity. This cylinder is watertight except in two chambers in the upper part at each extremity. When the downstream water level does not rise more than 3 ft. or so above the bottom of the dam, the weight of the cylinder is sufficient to counterbalance the pressure; but when the water level rises above this limit the water enters the two chambers, giving the cylinder added stability. The racks in the case of this dam are inclined at an angle of 45° only along the upper part. Toward the bottom the pitch is increased, attaining 4 to 1. This increase in pitch is made on a radius of 10.46 ft. The steepness of the bottom part of these racks gives the dam better bearing against water pressure tending to raise it. The weight of the cylinder is 193,600 lbs.

The operating apparatus includes two steel cables of 1.8 ins. diameter, each formed of six strands. The two cables are rolled on drums, and to raise the cylinder above high water, that is to say, 13.12 ft., an electric motor of 18 HP. is employed, and the operation takes less than a quarter of an hour. The mechanism is also provided with four cranks, by means of which the dam can be lifted by hand. The cranks drive a worm gearing through chains, and this, in turn, meshes with a train of gears and a chain to the hoisting drums. When lowered this enormous cylinder effects a rise in the river of 6½ ft.

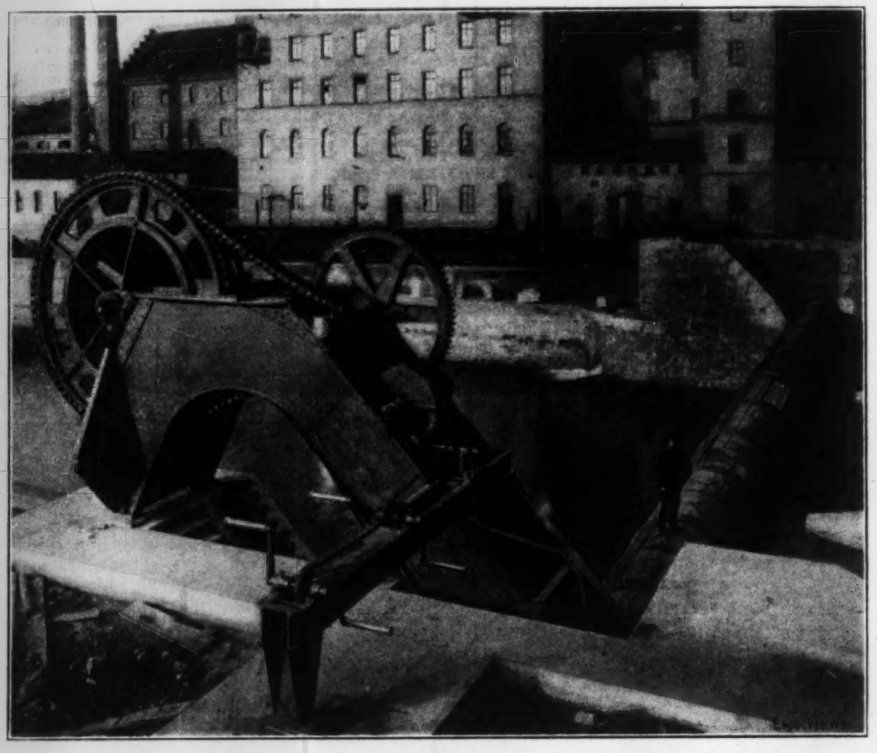
The first dam designed differs materially from the second in the method of raising the cylinder. It was designed to be hauled upward from its



VIEW OF ROLLING DAM AT SCHWEINFURT, BAVARIA, SHOWING SILL.

*70 Boulevard Charlemagne, Brussels, Belgium.

lowest position by cables on each end. In the second dam, the driving mechanism is all located at one end. When the downstream level of the water rises, the pressure would have a tendency to lift the gate. The cylinder itself is watertight, to prevent the freezing of the water which might otherwise collect in it, but an interior pipe is provided, open at each end of the dam, but shielded by its interior location from the cold. This pipe is filled with water to secure greater stability. The racks in the case of the second larger dam are



VIEW OF ROLLING DAM AT SCHWEINFURT, BAVARIA, SHOWING OPERATING MECHANISM.

placed at an angle of 45°. The cylinder in its lowest position rests on a sill of oak and the tightness of the dam at each end is provided for by a band of leather around the periphery. The weight of the movable cylinder of the first dam is 158,400 lbs. To bring it above the level of the highest flood it is necessary to raise it a distance of 16.4 ft. It is arranged for hand working, with six men on each side. Assuming that each man can perform work equivalent to 57.75 ft.-lbs. per second, and allowing for an efficiency of 35% in the hoisting mechanism, the time required to lift the cylinder the given distance is determined as follows, remembering that 12 men are engaged all told: $158{,}400 \times 16.4 \div (57.75 \times 12 \times 0.39) = 10{,}710$ seconds, or three hours. To lift the cylinder above ordinary freshets, only about half this time is consumed.

Among the conditions first established, and under which the dam was to be constructed, there were to be erected in the stream no piers or other supports that might interfere with the free movement of the ice in the spring. Not even temporary supports that could be removed upon the general breaking up of the ice or even at the close of navigation were allowed, simply because in order to insure their stability, foundations or the like would have been necessary to sustain them, and these would become permanent obstructions likely to be damaged by freshets.

HISTORICAL SKETCH OF THE CORPS OF ENGINEERS, U. S. A.

The Engineer School of the United States Army is now issuing a series of historical papers relating to the Corps of Engineers and to engineer troops of our army. In the current number of these "Occasional Papers" is found an historical sketch of the Corps of Engineers compiled by Brig.-Genl. A. A. Humphreys, former Chief of Engineers. While this sketch was written in 1876, it deals in an interesting manner with the formation of this body of engineers and a brief abstract follows.

Upon the breaking out of the War of the Revolution there was scarcely any engineering skill or talent in the patriotic service; and as it was important that such officers should be appointed for the Continental Army Congress, on June 16, 1775, Resolved, That there should be one Chief Engineer for the "Grand Army"—and that his pay should be "$60 per month," and that he should have two assistant engineers at "$20 per month each." The same resolution provided for one Chief Engineer and two assistants for the Army in a separate department, at the same rates of pay. This pay was equivalent to the then pay of a Colonel and Captain and the officers first appointed were commissioned in these grades.

On Dec. 27, 1776, General Washington was authorized by the Continental Congress to raise additional troops for service and to establish their pay, and among the troops mentioned in this resolution was "a corps of Engineers." Gen. Humphreys says that it is probable that under this law some organization styled a Corps of Engineers was established in the Army, under the rules and regulations of Gen. Washington.

Among the foreign officers who entered the American service some were educated as military engineers; and early in 1777 four officers from the royal corps of engineers of the French army were commissioned as engineers in the Continental Army. One of these—Louis E. Begue du Portail—was made Brigadier General and ranked all other engineers in the service; of the others two received the rank of Colonel and one that of Lieutenant-Colonel of Engineers.

On March 6, 1778, a Committee of Congress presented a plan for forming a Corps of Engineers; and on May 27, 1778, a resolution was passed by Congress establishing three companies of engineers and fixing the pay of the officers and men. The Captain was to receive $50 per month, the Lieutenants, $33.33 1-3 each; the sergeants, $10; the corporals, $9, and the men, $8.33 1-3 each per month. These were the first companies of engineer troops organized in our service; and their duties were defined in the resolution as that of instructing fatigue parties in the "fabrication" of field-works and repairing injuries done to these works by the enemy's fire. Other resolutions relating to these troops were passed by Congress; and on March 11, 1779, it was resolved—"That the engineers in the service of the United States shall be formed in a corps and styled the 'Corps of Engineers,' and shall take rank and enjoy the same rights, honors and privileges with the other troops in the Continental establishment." The same law ordered that a commandant of the Corps of Engineers should be appointed by Congress. Brig.-Gen. du Portail was the same day appointed Commandant and held that office until after the surrender of Cornwallis at Yorktown. For his "distinguished conduct in the seige of York" he was promoted to the rank of Major General by a resolution of Congress, dated Nov. 16, 1781. In November, 1783, this Corps of Engineers and its companies of sappers and miners were disbanded and mustered out of the service.

Until 1789 nothing occurred which required the service of military engineers. But on the inauguration of the new Government of 1789, the Secretary of War, Gen. Henry Knox, recommended, as a part of the military establishment of the United States, "a small corps of well-disciplined and well-informed artillerists and engineers." Nothing was done with this recommendation, and when Congress—on March 20, 1794—authorized the President to fortify certain harbors, the President directed the temporary employment of a number of engineers to superintend this work. Those employed were all of foreign birth. But on May 9, 1794, Congress provided for a corps of artillerists and engineers to serve for the term of three years. The entire number consisted of 992 officers and men, and the corps was stationed at West Point for preliminary training.

At the same time a military school was organized at West Point; but the apparatus and books were burned in 1796 and the school was suspended until 1801, when it was reorganized under Major Jonathan Williams, of the Second Regiment, Corps of Artillerists and Engineers. The organization of the Corps of Engineers was completed early in 1795; and the first officers were: Lieut-Col. Commandant Stephen Rochefontaine and Majors Henry Burbeck, Louis Tousard, J. J. U. Rivardi and Constant Freeman. By Act of Congress of March 3, 1795, the Corps of Artillerists and Engineers was continued indefinitely and its completion authorized. On March 16, 1802, an Act fixing and materially reducing the military establishment, abolished the Corps of Artillerists and Engineers, and from it created a regiment of artillerists and a corps of engineers. This latter corps was to consist of one engineer with the rank of Major, two assistant engineers with the rank of captain, two with rank of first lieutenant, two with rank of second lieutenant and there were to be ten cadets. This corps was to be stationed at West Point and it was to constitute "a Military Academy." Under this Act, Major Jonathan Williams was made Superintendent of the Military Academy April 13, 1802. This was the beginning of the present Corps of Engineers and of the Military Academy at West Point, and it is interesting to here note the names of the first members of the corps on record. After Major Williams, the Superintendent, we have Captains William Amherst Barron and Jared Mansfield; First Lieutenants Peter Anthony Dransey and James Wilson; and the first three students were Joseph Gardner Swift, Simon M. Levy and Walker Keith Armistead. The charge and superintendence of the Academy remained in the hands of the Corps of Engineers until July 13, 1866, when the superintendency passed to the army at large.

The Board of Engineers for Fortifications, which exists to the present day, had its origin in an order of the War Department of Nov. 16, 1816. The Topographical Engineers, a number of whom had been serving for nearly two years under the Chief Engineer, were regularly assigned to the Engineer Department and made subject to the orders of the Chief Engineer, on July 2, 1818; the order being issued by John C. Calhoun, Secretary of War. At this time the Engineer Department included the Corps of Engineers, the Topographical Engineers and the Military Academy.

By Act of Congress of April 30, 1824, a "Board of Engineers for Internal Improvement" was organized; and to it was assigned the duty of causing the proper surveys, plans and estimates to be made relating to such roads and canals as may be deemed of "national importance in a commercial or military point of view, or necessary for the transportation of the public mail." This first board was made up of Bvt. Brig. Gen. Simon Bernard, Lt. Col. Joseph G. Totten and Mr. John L. Sullivan, Civil Engineer. This board continued until 1832, when it seems to have been discontinued; but its functions since that date have been performed by special boards on river and harbor improvements, organized for temporary service on particular work.

On June 22, 1831, a regulation of the War Department made the Topographical Bureau of the Engineer Department a distinct Bureau of the War Department, with the officer in charge directly under the orders of the Secretary of War. In 1837 the Corps of Topographical Engineers was organized, and on June 18, 1839, about seventy or more pieces of works of improvement of harbors and rivers were transferred to this Corps. By an Act of March 3, 1863, the Corps of Topographical Engineers, as a distinct branch of the Army, was abolished and merged into the Corps of Engineers. The Corps of Topographical Engineers really had its origin in the Continental Army, when Gen. Washington, on July 25, 1777, was authorized to appoint Robert Erskine, "or any other person he may think proper," geographer and surveyor of the roads, to take sketches of the country, the seat of war, and to have the procuring, governing and paying the guides employed." Simon De Witt succeeded Robert Erskine in this duty in 1780, and Thomas Hutchins held a similar position in 1785. In 1813 eight topographical engineers were provided for by Congress and the appointments were made by detailing officers from the line to perform this duty. In 1818 the Topographical Engineers were constituted a part of the Engineer Department, and a Topographical Bureau was established by the War Department, the officers of the corps being engaged in explorations in the West and in surveys for seaboard fortifications. This was the official beginning of this important corps, the remainder of its history being already outlined above. Gen. Humphrey's original paper enters into much detail as to names, dates and Acts of Congress effecting the engineer organization of the Army of the United States.

STONE HANDLING PLANT OF THE LAKE SHORE STONE CO., BELGIUM, WIS.

The Lake Shore Stone Co., of Milwaukee and Belgium, Wis., has a plant for producing crushed stone, and has equipped this plant with special apparatus for handling and conveying the stone. The plant and quarry are at Stone Haven (post office, Belgium, Wis.), on the shore of Lake Michigan and about three miles from the Chicago & Northwestern Ry. at Belgium. There is no rail communication, and all the stone is shipped by the company's steamer, which is equipped with mechanical conveyors for unloading its cargo. The company owns about 190 acres of land, with one mile of lake front. The stone is a dolomitic limestone, with some shaly beds near the surface, and very little surface stripping is required. Artesian well borings show the depth of the rock bed to be about 200 ft., and the depth of the present workings is about 30 ft. The stone is used for macadamizing, concrete work, etc., and large quantities are also shipped to the Illinois Steel Co.'s works at Milwaukee to be used as flux in the blast furnaces. The stone selected for this latter purpose contains about 1% of silica. We are indebted to Mr. A. J. Blair, the General Manager, and Mr. Edward Burns, the Superintendent, for information furnished during a recent visit to the plant.

At the quarry, the rock is broken up by charges of black powder, dynamite being also used in some cases, and the loose masses are thrown down by bars to the floor of the quarry where the large blocks are drilled and broken up by powder. The stone is then loaded by hand into steel cars on a number of radial tracks, but after that there is no further manual handling of the stone. The cars are hauled by mules to the foot of a double-track incline leading to the crusher house, up which they are hauled by cables and automatically dumped. The cars dump directly into the hopper of a No. 9 Gates crusher, and a 36-in. bucket elevator raises the crushed rock 75 ft. to two revolving screens which sort the stone into five sizes, delivering these to separate bins. The screen rejections or tailings are returned to a No. 6 Austin crusher to be further reduced in size. A belt conveyor from each bin carries the stone out to a

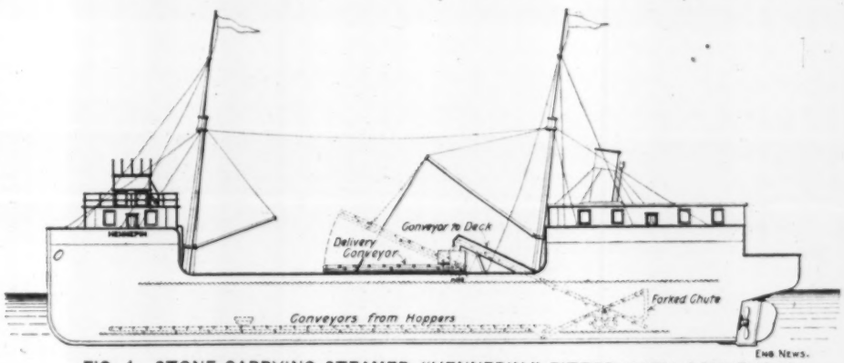


FIG. 1. STONE-CARRYING STEAMER "HENNEPIN," FITTED WITH CONVEYORS; LAKE SHORE STONE CO.

stock pile, beneath which is a tunnel containing a second conveyor. Gates in the tunnel can be opened as required to allow the stone to fall onto the conveyor, which delivers it to a hopper in the crusher house.

This hopper is directly over the outgoing track of a Mead endless-cable railway, equipped with double-truck dump cars of 3 cu. yds. capacity. Each car is stopped as it comes under the hopper, where the attendant loads it by opening the bottom gate of the hopper, and then grips it to the cable which runs at a speed of about 240 ft. per minute. The car then passes out to the shore, up an incline trestle to a pier built on cribwork running out into deep water. The pier has its rails about 50 ft. above the water, and at the end is a storage building 30 × 150 ft., and 60 ft. high, having eight pockets with a total storage capacity of 1,200 yds. From the pockets the stone is delivered by chute to the hold of the vessel. Beneath the entrance to the storage house is located the cable driving plant, the cable going down to the drums and then returning to the track to take the cars through the storage house and back to the crusher house. At the side of the track are hinged trips, which when thrown into position engage a roller on a lever hanging below the car, thus raising the lever so as to release the side doors of the car which are hinged at the top and swung out, allowing the contents to slide down the inclined bottom and fall into the pocket. The car can thus be dumped at any one of the pockets, and an attendant closes and latches the doors after it has been dumped. The total length of the railway is 1,500 ft. and at each end is a loop of 12 ft. radius.

Belt conveyors were formerly used to carry the stone from the crusher plant to the pier, but were found to be expensive in first cost and maintenance, and required more power than the present cable traction system, besides which they gave trouble in winter for such long distances, although the shorter belts used at the stock piles give general satisfaction. The distance from the crusher to the pockets on the pier was 1,270 ft. (now increased to 1,390 ft.) and this distance was covered by two lengths of 24-in. conveyor belts, the first discharging into the second. Another objection to the belt system was that only one size of stone could be conveyed at a time. With the railway system, the cars can be loaded with different sizes of stone and discharge into separate bins; this arrangement has almost entirely eliminated night work, which was very generally necessary when the belts were used. Two motors of 40 HP. and 50 HP. were used to operate the two lengths of belt conveyors but the railway is operated by a single motor of 50 HP. and has a greater capacity.

The belt conveyors now in use are Webster troughed belts carried on combination idlers; a carrying shaft and pulleys run in trunnion bearings supported in a stand at each side of the belt, these stands also carrying an angle iron cross-bar which forms the support for the inclined pulleys that trough the belt. All bearings are lubricated by compression grease cups, which make them dust proof. The idlers which carry the return belts are composed simply of shafts and pulleys carried in trunnion bearings supported in cast-iron stands on each side of the belt.

The pier as originally built was not strong enough to resist the action of the heavy waves, which caused the crib to shift. After the close of navigation in 1903 the reconstruction of the pier was commenced, while the building containing the storage pockets was at the same time moved 120 ft. further out into the lake. The strengthening of the cribwork was left until the water was frozen along the shore to a depth of 5 ft. A trench was cut through the ice parallel to the crib, and about 15 ft. distant. In this cedar logs, not less than 24 ins. diameter and 12 to 18 ft. long, were laid end to end. The ice between the trench and the old crib was then removed, and the space filled with stones of 50 to 100 lbs. in weight. Crushed stone of 2½-in. size was then shoveled in to fill the voids. When this filling was level with the logs, cross ties not less than 10 ins. diameter, and projecting 9 ins. beyond the logs, were placed 3 ft. apart and secured to the logs by 1-in. drift bolts 18 ins. long. A second

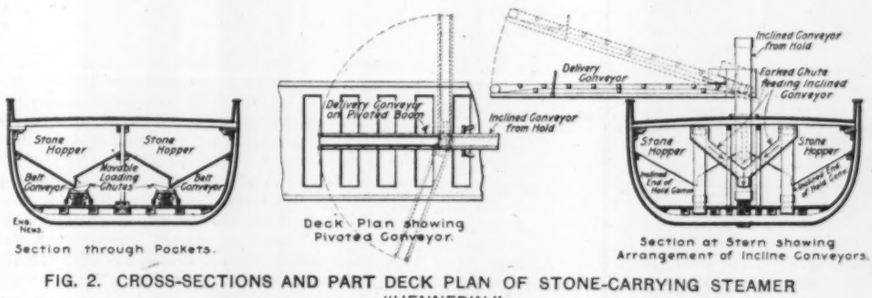


FIG. 2. CROSS-SECTIONS AND PART DECK PLAN OF STONE-CARRYING STEAMER "HENNEPIN."

row of logs was then placed, breaking joint with the first row; and stone filling and wooden cross ties were placed as before. These operations were repeated until a crib 12 × 15 ft. and 450 ft long had been built, making a total of 600 cu. yds. The company had all the materials at first cost, and the labor item cost a little over 46 cts. per cu-yd. It is estimated that had the work been done at any other season than when the water was frozen the cost would have been at least twice as great. The work was designed and carried out under the direction of the superintendent and foreman.

There is no railway connection with the plant, and all the coal is brought in by the company's steamer, which discharges it into an elevated flat-bottom bin at the shore end of the storage house on the pier. From this it is drawn through trap doors into small dump cars on a track on the cribwork, the cars being hauled by a small locomotive. There are four water tube boilers of 150 HP. each, with Hawley down draft furnaces.

The power plant comprises a 250-HP. engine for the crushers, a 200-HP. engine belted to a 125-KW. generator, and an Ingersoll-Sergeant air compressor of 382 cu. ft. capacity, compressing air at 100 lbs. pressure in the receiver. A 50-HP. motor drives the conveyor belts at the crusher plant, and a 50-HP. motor at the pier drives the cable railway machinery. The attendant at the pier has a switch for controlling the cable, and has also a telephone to the crusher plant so that he can give directions as to the size of stone wanted. A line of 3-in. pipe about 2,000 ft. long is laid around the top of the quarry, with branches down into the works for connecting to the hose of the drills used in drilling holes for breaking up the large blocks. A large Ingersoll-Sergeant drill is used to drill the vertical holes for charges used in throwing down the face or breast, and an Oldham drill for drilling or plugging the large blocks which have to be broken up by blasting. This latter is operated on the same principle as the pneumatic hammer. An Ingersoll-Sergeant hammer drill (on the same principle) is also being tried for this purpose.

The plant also includes a Lidgerwood cableway, 500 ft. in length, which spans the quarry, the towers being mounted on wheels running upon rails. This was installed to handle rip-rap stone. Wooden boxes were loaded in the quarry, lifted out by the cableway and deposited on cars which were run out on the cribwork of the pier, where they were loaded onto a scow fitted with a derrick for handling them.

About 100 men are employed, and the average capacity of output is about 600 cu. yds. per 10-hour day, which can be increased to 750 or 800 cu. yds., when required, by the addition of more men in the quarry.

As already noted, all the product of the plant is transported by water, and for this purpose the company has its own steamer, which is of special interest in being equipped with apparatus for unloading its cargo. The "Hennepin," Fig. 1, is 209 ft. long, 35 ft. beam and 12 ft. deep, with a compound engine of 450 HP. placed at the stern, as in most lake steamers. The hold is built to form two longitudinal hoppers with a total capacity of 700 to 1,000 cu. yds. of stone, as shown in the cross sections, Fig. 2. The hoppers have bottom gates which discharge the stone through movable loading chutes upon the conveyors. Under these hoppers run two 24-in. belt conveyors, rising on an incline at the stern and discharging through a forked chute onto a single 32-in. inclined belt conveyor rising above the deck. This latter discharges its load upon a belt conveyor carried by a 54-ft. pivoted boom, so that the stone can be delivered onto a stock pile or into cars without any handling and without assistance from the shore. The gates of the hoppers are opened as required by attendants in the tunnels containing the conveyors, these tunnels being lighted by electricity. The conveyor system on this steamer was installed by the Webster Mfg. Co., of Chicago, and a cargo of 700 cu. yds. can be unloaded in 7 to 8 hours. The three conveyors in the hold are driven by a large vertical engine, and a small horizontal engine is directly connected to the outboard or delivery conveyor.

THE MANUFACTURE AND USE OF DIAMOND TOOLS.*

By G. C. Henning,† M. Am. Soc. M. E.

Steel is the one material in almost universal use for cutting and working stone, metal, wood and other materials, because of its great strength and the degree to which it can be hardened. There are some materials, however, which, because of their hardness, structure or non-conductivity of heat, cannot be worked economically by means of steel tools. The latter become worn rapidly, losing their shape and dimensions to such degree and extent that the work produced becomes inaccurate, causing constant interruption of operation, loss of time, and necessitating frequent replacement by new tools or regrinding or shaping of the old ones. This causes great expense and delay in production. The great friction produced by cutting materials in some cases draws the temper of steel tools, making them useless. Hard rubber paper and hardened steel cannot be readily worked by use of steel tools, as is also the case with hard stone. In these cases a much harder material is required, and for this reason diamond is used.

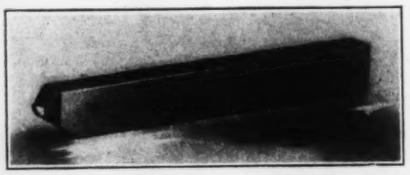


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

FIGS. 1-5. LATHE-TOOLS WITH DIAMOND CUTTING-POINTS.

The diamond which is used in diamond tools is of two kinds, totally different in appearance and quality. (1) The first variety has a very dark purple brown color on the surface, but a purplish grey fracture, is an amorphous, granular mineral with rarely any crystallization visible or traceable, and is called Carbon or Black Diamond. It is the hardest material known and has great strength. (2) The second variety, called Bort, is entirely crystalline and is generally transparent, and may be of all colors of the rainbow as well as clear and transparent as glass. The clear bort is considered of greater hardness than all other bort except some which is almost black. Bort is extremely brittle and is readily fractured or "cleaved" in the three directions of its cleavage planes parallel to the sides of the octahedral crystal, in which shape it is most commonly found. The dodecahedral crystals are also readily cleaved in a similar manner.

METHODS OF WORKING.—Diamond is worked by cutting, polishing and drilling, and as these processes are but little known, they shall be here described.

In order to produce a round or cylindrical shape, either for round-nose tools or sharp points, the diamond is set in a very strong cement on an adjustable face-plate of a small lathe running at about 350 r. p. m. Then a suitable stick or handle, at the end of which a diamond is secured by the same strong cement, is used like a hand tool, so that one diamond bears against the o Both will then wear off, and any desired r shape may be produced. Polishing is done placing the diamond, properly weighted, up flat disk of cast-iron running at from 2,5 3,500 r. p. m. This cast-iron disk is covered a mixture of very finely powdered diamond and olive oil, and in course of time the diam rubbed down thereon obtains a most highly ished surface. In this manner the intersection the different polished planes produce very sh cutting edges, which can be made of any angle

Carbon or black diamond, however, cannot polished. It is cut the same as bort, and fl surfaces are produced by rubbing down. The surfaces do not become polished in this proce on account of the amorphous nature of the sto

Diamonds are drilled by means of fine steel needles served with a mixture of oil and diamond dust. Either the diamond (mounted with cement on a small face-plate) or the drill is rotated, the speed used being as high as 10,000 to 13,000 r. p. m. In either case the stationary part is "jumped" against the rotating part by a cam, the pressure of the contact being regulated by a spring. This allows the diamond dust to feed down to the bottom of the hole. The time required to drill such a hole, for example in a diamond wire-drawing die, depends upon the thickness of the stone and the diameter of the hole; in the case of an ordinary die it may be several hours or even many days.

Usually the stone is prepared for the drilling by "cutting" a conical depression on either side, in line of the hole, leaving only a thin central portion to be drilled. This procedure gives the proper form of hole for wire-drawing, with a minimum of finishing work.

After the hole has been drilled, leaving it in a more or less rough and unround condition, the diamond is mounted on a polishing machine running from 3,500 to 6,000 r. p. m., while a steel needle, truly concentric with the hole, is made to move forward and back in it rapidly, while oil and diamond dust is fed frequently. Thus a smooth round hole of proper shape and correct diameter is produced.

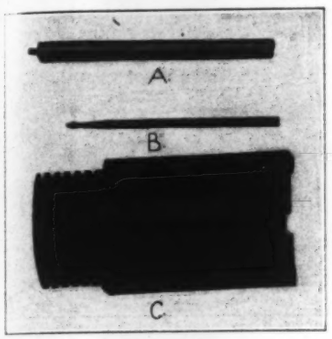
USES OF DIAMONDS.—All kinds of grinding wheels, being made of extremely hard materials, are most readily kept free from filling or glazing and in perfect shape by diamond tools. The compressed carbon which is used for brushes in electric machines is most advantageously worked by diamonds. In certain classes of work, where great accuracy and precision are primary requirements, or extremely fine lines are essential, the diamond is the only material that answers the purpose. Thus lithographers, engravers and scale-makers use diamond tools for fine work. Hardened steel

*Based on a paper read before the American Society of Mechanical Engineers, December, 1904.

†Consulting Engineer, 36 Gold St., New York, N. Y.

spindles are accurately turned by diamond tools.

Another very important field of production, in which diamond is all but imperative to obtain satisfactory results at reasonable cost, is that of wire drawing. Formerly all small wire was drawn through holes in hardened steel plates, but these wear so rapidly that the wire soon loses its caliber and becomes unround. As it is all-important, especially in electric work, that the wire be of absolutely uniform size, so as to maintain constant resistance and permit symmetrical distribution of weight about spindles and shafts, it became necessary to use a material harder than steel, and hence diamond was again resorted to.



A. Lens Drill.
B. Dental Drill.
C. Rock Drill.

Fig. 7. Three Diamond Drills.

This made it possible to avoid delays in replacing worn dies, and because of the great permanence of accuracy of the calibers of the holes in the diamonds, materially reduced the cost of producing fine wire of copper, brass, steel, iron, nickel, and of other metals.

It is, of course, well known that stone is drilled and sawed by the use of diamonds, these having been used in core drills, which, in an extreme case, have cut solid cores of about 21 inches diameter.

In diamond drills, stone saws and grinding-wheel dressers, the rough diamond is used in appropriate holders, set by staking, by brazing, by soldering, or by casting molten steel around the diamonds. A peculiar property of the diamond is that it can be plated like any metal; this property is made use of in the galvano-plastic setting. The galvano-plastic setting consists in first plating the diamond and then casting molten metal around it, which alloys with the deposited metal. Thus an absolutely firm and rigid setting is produced. Very high temperature does not affect the diamonds either in their hardness nor, when sound, in their solidity, and does not produce checks or other flaws. A temperature higher than that sufficient to melt steel will, however, burn the diamond, and the electric arc will readily do so.

A diamond drill bit is shown at the bottom of the accompanying Fig. 7; in such a bit the diamonds are set in steel nibs, which are soldered or brazed into their proper places in the bits. The diamonds project slightly on both outside and inside to produce clearance, so that both the drill and the core may be readily removed, and the hole may be flooded with water during drilling.

By this method of using diamonds set in steel nibs, the expert diamond setter may be dispensed with at the mine because any mechanic is competent to insert these nibs into the drill-bit properly. The more common and older method of setting diamonds in drill-bits consists in cutting or drilling holes in the drill-bit to approximate the shape of the diamond, then filling the spaces around it with copper or other malleable material, and then staking the stone firmly. This, of course, often causes breakage of the diamonds, which is entirely avoided by using diamonds set in cast steel nibs.

Glass and china are best drilled by diamond drills. Tools for this purpose are made of a triangular splint of diamond, generally provided with a flat, triangular pyramidal point. When using turpentine as a lubricant, such a tool penetrates glass and china more readily than any other tool, and lasts for from one to two years unless broken by carelessness or accident. Fig. 7 shows two such tools. The upper one is used for drilling spectacle lenses, etc., while the middle one is used for drilling natural and artificial teeth, in dentistry.

The use of diamonds as the cutting points of lathe tools in the machine shop has already been referred to. The diamonds in these tools are all shaped by cutting and polishing or rubbing down, as before described, to imitate the customary shapes of steel tools. They are sometimes set by the galvano-plastic method, in which case the resulting cast bronze nib containing the diamond is brazed into a steel holder. By the improved method, that of casting steel around the diamond, a simpler and more secure setting is produced.

Several diamond lathe-tools are grouped in the views Figs. 1 to 5. Fig. 1 shows a round-nose tool, Fig. 2 a V-point or sharp-nose tool, Fig. 3 a square-nose tool, such as is used for producing very high finish on hard rubber, Fig. 4 a rough-stone tool used for turning paper calender rolls, and Fig. 5 a tool with removable round steel bit, in which the diamond is set. The rough-stone tool, Fig. 4, is made simply by clamping a rough piece of black diamond in proper position between two pieces of steel adapted to be held in a tool-post. Calender rolls must be very accurate and smooth, which is secured in best degree by a shaped, cut diamond tool of this character.

Tools such as just shown are commonly used for turning hard rubber, because the diamond lasts a long time without wear, and produces absolutely smooth and accurate work, while steel tools wear off in a few minutes at most and get very hot. Diamond tools are economically advantageous, moreover, because very high speeds can be used, 450 to 500 ft. per minute being common.

Tools exactly similar to those above shown are advantageously used also in turning steel, and especially hardened steel, in which latter case they replace the grinding wheel. The advantage of diamond tools for turning highly accurate metal work over all tools is that the absence of wear of diamonds insures that the finished work has the same diameter throughout its length.

The greatest source of loss in using diamond tools of the kind described, whether for rubber or for metal, is the breaking of diamonds by accident or careless handling. Diamond tools require to be very much more carefully handled than steel tools, and when so handled they prove exceedingly economical, as their life is very long and the expense of constant sharpening is saved.

A diamond die for drawing wire is shown in section in Fig. 6. The size of the hole is much

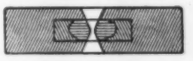


Fig. 6. Section of Diamond Wire-Drawing Die.

exaggerated in this drawing. The stone itself is set in a steel ring, or rather the ring is cast around the stone. This gives the stone great resistance against bursting. Bronze is then cast around the steel setting to prevent corrosion of the steel by the substances used to lubricate the wire as it passes through the die.

The holes in these diamonds are rarely made larger than .064-in. diameter, because steel drawplates or dies are considered sufficiently accurate and economical for larger sizes, and because of the great cost of diamond dies. The smallest dies which have come to the notice of the writer had holes of .001-in. diameter, although clients have called for calibers as small as .00045, .00055 and .00065. It is common practice to make the holes in diamond dies accurate to .0001-in., which to many engineers may seem almost impossible, and is therefore here mentioned. In drawing copper wire, it is customary to draw a .064-in. wire in one pass from a rough wire of .072 diameter. Smaller sizes are then produced by the following consecutive reductions: to .053, .045, .040, .036, .032, .028, .025, .022, .020, .019, then by 1-1,000 down to .0075 and by half thousandths to .001. It may be mentioned that diamonds wear increasingly when drawing the following metals in the order stated, viz.: gold, silver, copper, brass, bronze, platinum, soft steel, nickel, iron, crucible steel (piano wire).

In order to show why such expensive material as diamond can be used economically, it may be stated that diamond dies wear up to eight years under constant use. One die of .004 caliber has, according to the record, drawn over 550,000 lbs. of soft copper wire. Diamond drills for drilling glass wear from one and one-half to two years before requiring recutting.

TEAMING YARDS AT RAILWAY STATIONS.*

By H. J. Pfeifer,† C. E.

In all of the large cities of the country large outlays have been made, and will have to be made, in the future, to take care of constantly increasing business in railway terminals, and involving the acquirement of extensive tracts of land in the business districts at almost prohibitive prices. It is probably a safe estimate to say that in large cities the amount of money invested by railroads in real estate is more than four times as great as the cost of all the improvements placed upon it after its acquirement. On account of this immense ground value in large cities, it is true economy to build improvements of the greatest efficiency and compactness.

The local freight business at a terminal may be divided into three classes: 1st, freight received and delivered through freight houses, 2d, freight received and delivered on team tracks, and 3d, industry freight or that received from and delivered direct to factories or warehouses by means of private tracks. The first and second class have this in common, namely that for both of them the railroad must supply roadways adjacent to its tracks or freight houses. Figures obtained from a reliable source show that on an average 35% of the local St. Louis freight tonnage belongs to the first two classes, and 65% belongs to the third class.

The freight included in the first two classes might be properly called teaming business, because the transfer of freight between shipper and railroad is effected by means of teams, and the facilities provided by railroads for this business, whether they consist of freight houses, tracks and roadways or only tracks and roadways, may properly be called teaming yards.

A teaming yard in a large terminal, if properly constructed, will have the following qualities:

(1) A track arrangement giving the greatest possible car capacity adjacent to the roadways and substantial track construction. If the ground is so shaped that comparatively short tracks, say not to exceed fifteen cars in capacity, must be put in, this can best be accomplished by the use of sharp curves and short switches, as these are great economizers of space. Curves of 20° and in extreme cases 30° are not too sharp, and should be used. If it can be avoided, the switching should not be done on the main track, as that always involves serious loss of time to the switching crew, and thus impairs the efficiency of the yard.

On account of curved tracks and leads there is, of necessity, quite a proportion of the track space that is not suitable for delivery purposes, and it is not necessary therefore, except in very large yards, to provide any special classification tracks, the curved tracks and leads above mentioned being sufficient for this purpose.

The delivery tracks should be arranged in pairs and should be not less than 12 ft. c. to c.; 12½ ft. is better. Between the pairs of tracks space for roadways not less than 36 ft. between track centers should be allowed.

(2) The chief feature of a well designed teaming yard are properly graded and paved roadways. They should be at least as well built as the public streets connecting with them. This is very essential but frequently neglected. Those of you who have had occasion to note the conditions of the roadways in the average teaming yard, especially in the winter and early spring, must agree that it is deplorable. The stalling of teams, with the consequent beating of horses and other accompanying features is a matter of almost hourly occurrence in wet weather. Instead of the loading of wagons being governed by the amount the team can haul over the streets, a half load is often more than can be pulled through the mire in the teaming yard, as a result of such conditions, loss of time is inevitable in loading or unloading freight from cars, and this loss in turn reduces the capacity of the yard, often to a serious extent, and the shippers are dissatisfied on account of the delays and extra expense to which they are put, the poor roadway frequently doubling the teaming cost, already a large item of expense.

Where the yard is reached by paved city streets, the roadways should also be paved. A thoroughly satisfactory roadway of vitrified brick can be built at a comparatively small cost in the following manner: After the tracks have been laid the roadway should be excavated to a depth of 12 ins. below the surface of the finished pavement, and thoroughly compacted with a heavy horse or steam roller. Care shall then be taken to remove all soft or spongy

*From a paper read before the St. Louis Railway Club.
†General Superintendent Construction Street Dept., City of St. Louis.

ground in the foundation and replace the same with any suitable dry material. If possible, the roadbed should be built on a grade, so as to be self draining, great care being taken to leave no pockets that will hold water. Water is the greatest enemy to a good pavement as it is to a good track. After the roadbed has been treated as above described, a foundation course of macadam is spread to a depth of about 6 ins. and thoroughly rolled with a heavy steam roller. This macadam after rolling becomes so dense and compact that a wagon driven over it leaves no noticeable mark. On the macadam foundation is spread a layer of sand, which is washed into the interstices between the stones of the foundation, and the

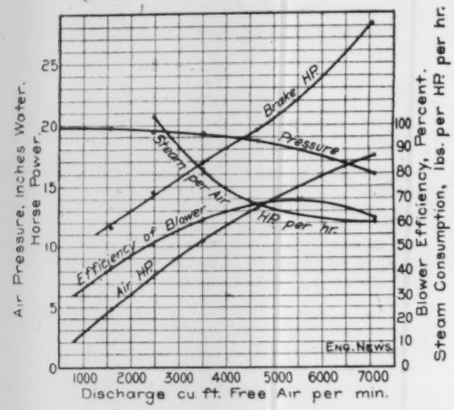

Air Pressure, Inches Water. Horse Power.
Steam Consumption, lbs. per HP per hr. Blower Efficiency, Percent.
Brake HP
Pressure
Steam per Air HP
Efficiency of Blower
HP per hr.
Air HP
Eng. News.
Discharge cu ft. Free Air per min.

Fig. 1. Diagram of Results of Test of 20-HP. De Laval Steam-Turbine Blower Set.

operation is repeated until they are all filled. The object of washing the sand between the stones is to prevent the sand cushion to be placed upon the foundation from slipping into the same, thus causing a settlement of the pavement proper. Upon the prepared foundation is spread a sand cushion about 1½ ins. thick, upon which is laid the vitrified brick pavement. The brick should be set on edge, and should be paved close together in straight rows, and should conform accurately to the surface of the pavement.

After this is done the pavement is again rolled and the bricks brought to an even surface. Hot, dry sand is then spread upon the pavement, and swept into the joints until they are filled; after which the pavement is ready for use.

In order to protect the edges of the pavement a curb made of oak crossing planks set on edge is used next to the tracks.

A pavement such as is here described will be found fully as serviceable as more expensive pavements, just as cheap to maintain and just as satisfactory to shippers. In fact the maintenance for several years will be almost nominal. It will cost, according to present prices of materials, assuming that all of them can be delivered on cars and that the excavated material can be removed on cars, not to exceed $1.40 per sq. yd., or to put it in another way, the roadway space in front of a 40-ft. car will cost about $80, or only about one-twentieth of the value of the ground upon which it is placed.

With a roadway, such as described above, a team can haul fully twice the load that it can drag over an unpaved roadway. Stalling of teams will be entirely eliminated, the capacity of the roadway will be more than doubled, because its capacity is measured not by the number of tons hauled over it, but by the number of teams doing the hauling, and the rapidity with which they can do their work. This in turn brings about a more rapid loading or unloading of cars, materially reducing the car detention, which determines the working capacity of the yard.

The average value of property suitable for terminal purposes in the heart of St. Louis, that is as far west as Grand Ave., as far north as Bremen Ave. and as far south as Cherokee St., is about $3 per sq. ft. The actual space occupied by a 40-ft. car on a teaming track, including its proportion of roadway, is 960 sq. ft. If to this is added its proportion of the space occupied by switches and switching tracks, as well as its proportion of ground, which, on account of its location, is not available for use, all of which is certainly not less than one-third of the net area occupied by the car, we find that for each car length of delivery space an extra area of 1,280 sq. ft., costing $3,840, is required. The annual rental value of this ground at 5% interest is $192.50, or almost 53 cts. per calendar day. As the average detention of each car for a number of yards in this city is, by actual count, somewhat in excess of two days, we find that $1.20 per car is not an excessive estimate of the ground rent alone for the space occupied by every car placed on a team track in the business district of St. Louis. If to this $1.20 expense is added the cost of switching, maintenance and general expenses, we readily see that a $2 switching charge for placing a car on a team track, which is, I believe, the usual rate, is not only not exorbitant, but doubtless in many cases does not cover the actual expense incurred.

As an illustration of the value to a railroad of a good pavement in a teaming yard, the following report of business done in a certain yard during a few days in November, 1903, and the corresponding period in November, 1904, is submitted. In 1903 the roadways were unpaved, and since then a vitrified brick pavement has been laid.

In the earlier period 56 cars were unloaded and the average detention per car was 56 hours. This year 110 cars were unloaded in the same length of time, the average detention per car being 53½ hours, or practically double the amount of business with a decrease of 2½ hours per car, or 4½% in car detention. As there was no change in the track arrangement of the yard, and as the general business of the line in question was as heavy in 1903 as in 1904, it clearly indicates that the results shown are due to the appreciation by shippers of the value of good roadways, and that the company providing them, other things being equal will get the business.

Another illustration is the contrast in the condition of two teaming yards in East St. Louis belonging to the same company, both of which are equally accessible. One has a good paved roadway, the other has not. The average detention per car by consignee for several days in November, 1904, was 49.2 hours in the paved yard and 57.6 hours in the unpaved yard, a difference in favor of the paved yard of 8.4 hours, or 14.6%. The superintendent of the line says that their paved yard is always crowded to its full capacity, while it is almost impossible to get shippers to receive their freight in the unpaved one; in fact, shippers anxious to receive their freight have been known to wait several days for a place for their car in the paved yard, rather than go to the unpaved one where immediate delivery awaited them.

The maintenance and cleaning of a paved roadway is a comparatively small matter, and will cost hardly one-tenth as much as the maintenance of a macadam roadway under the same traffic. Any one responsible for the maintenance of macadam roadways under heavy traffic has his life made miserable by the complaints of shippers and freight agents during bad weather. He spends hundreds of dollars for labor cleaning the roadways, and for macadam to fill the holes in them. And next year he has to do it all over again. In fact two or three years repairs require as much macadam as the foundation of the pavement described in this paper. Under such conditions it is manifestly poor economy not to install paved roadways.

EFFICIENCY TEST OF A DIRECT-CONNECTED ST[illegible] TURBINE FAN BLOWER SET.

By C. R. Waller.*

An efficiency test made recently in the tes[illegible] room of the De Laval Steam Turbine Co., T[illegible] ton, N. J., on a direct-connected set consisti[illegible] a 20-HP. De Laval steam turbine and a St[illegible] vant gas blower gives valuable information a[illegible] the performance both of fan blowers and of st[illegible] turbines. A report of the tests is submitted in

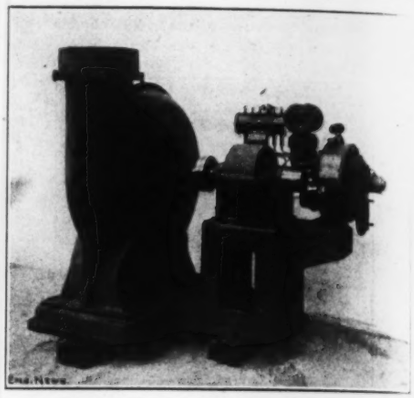


Fig. 2. View of 15-HP. Single-Geared Steam-Turbine Blower Set.

following. The test is the more interesting because, in order to obtain the maximum discharge desired, it was necessary to run the turbine at nearly 50% overload. The machine stood this load perfectly well, though of course the steam consumption per unit of power was higher than for rated load.

The set consisted of a No. 7 special Sturtevant extra-heavy gas blower coupled direct to the gear-shaft of a 20-HP. De Laval turbine. The turbine shaft ran at 20,000 r. p. m., the gear and blower shaft at 2,000 r. p. m. Blower and turbine were mounted on the same bed plate. The blower was designed to run at the speed actually used, viz.: 2,000 r. p. m. Its impeller is 29½ ins. in diameter and is of the enclosed type, with curved blades (see Fig. 4).

The purpose of the test was to determine the characteristic pressure-discharge curve of the blower, and the steam consumption of the set per air horse-power delivered. Specifically, the quantities to be determined were:

1. The pressure produced by the blower at constant speed. 2. The amount of air discharged. 3. From the preceding items, the air horse-power (A.HP.) and the characteristic curve of the blower. 4. The steam consumption of the set per A.HP., and the efficiency of the blower. The last-named item involved a knowledge of the performance of the turbine itself at various loads. This was obtained by separate brake test.

In order to measure pressure and volume of the

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FIG. 3. DOUBLE-GEARED SIROCCO BLOWER SET OF 150 HP.

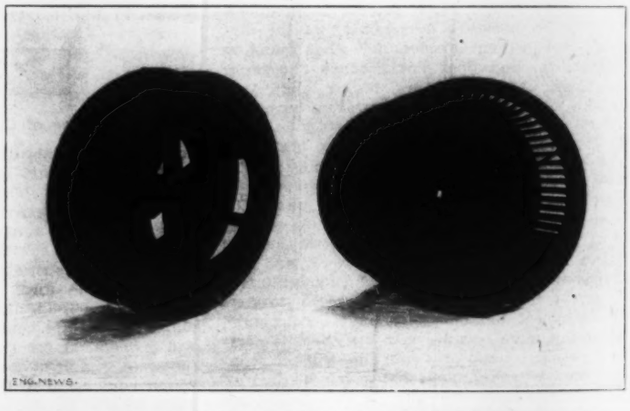

FIG. 4. IMPELLERS OF STURTEVANT AND SIROCCO BLOWERS.

air discharged, a wooden box 48 x 42 x 52 ins. was constructed and connected to the discharge opening of the blower. On top of the box a circular opening was made, over which converging air nozzles of different sizes could be placed. In front of the opening a Pitot tube of small diameter, and connected to a water gage, was attached, in such way that its receiving end, flush with the discharge edge of the nozzle, could be swung across the whole diameter of the nozzle. This was done in all the various tests; the variations in the Pitot gage reading at various points of the nozzle were noted, and an average value determined. The readings on the Pitot tube gage registered the head due to the discharge velocity in the nozzle, and from this the discharge could be computed.

The pressure produced by the blower was ascertained by means of a water gage connected to the box in a place where it was reasonable to suppose that the readings would not be influenced by the velocity of the air.

Six separate tests were made, five with the blower discharging through nozzles respectively 4, 5, 6, 7 and 9 ins. in diameter, the sixth test being made with the nozzle entirely shut off.

Besides the readings of the pressure and Pitot tube gage, the following observations were taken during each test:

The pressure of the atmosphere.

The temperature, relative humidity of the air, and vapor pressure, by means of a wet and dry bulb thermometer.

The temperature in the air box.

The steam pressure above and below the governor valve in the steam supply pipe.

The temperature of the steam.

The speed of the blower.

The steam consumption.

This latter was determined by means of a nozzle test, wherein a nozzle of the same shape and size as those used in the turbine was connected to the turbine wheel case by means of a pipe through which steam was discharged into a barrel of water placed on a scale. Between this nozzle and the barrel, a steam gage and a three-way cock were placed, the former to ascertain that the pressure on the discharge side of the nozzle at all times was below 58% of the pressure in the wheel case. This pressure at no time rose above 43 lbs., thus satisfying the requirements of an accurate test. The three-way cock was set, immediately before the test, to discharge the steam into the atmosphere, so as to remove all condensation in the pipes; then quickly turned to admit the steam into the barrel. The time during which the steam was discharged into the barrel was carefully noted, and the weight of the water in the barrel was taken before and after the discharge. The difference in these weights then gave the total steam consumption per nozzle for the duration of the nozzle test, which was three minutes for each test.

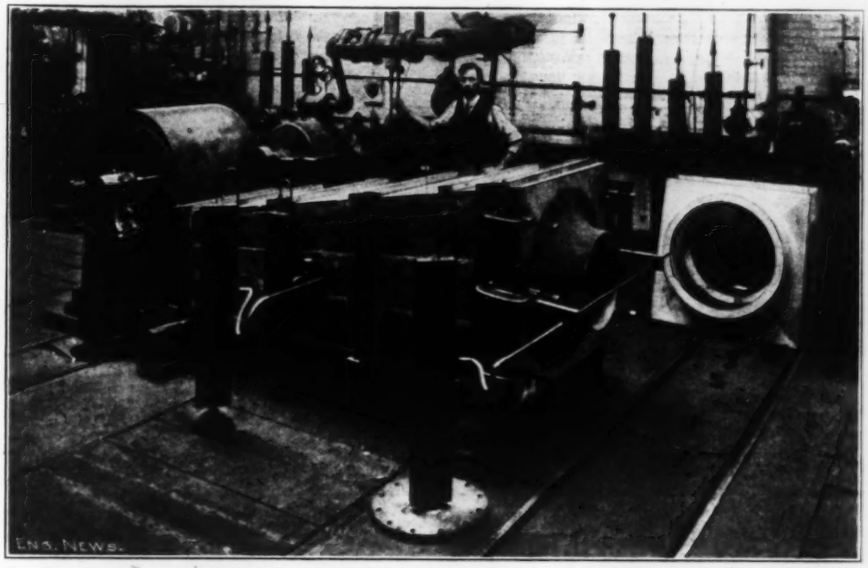

FIG. 5. ARRANGEMENT OF APPARATUS FOR EFFICIENCY TEST OF A STEAM-TURBINE SIROCCO BLOWER SET.

As the purpose of the work was to make a thorough test of the blower, steam nozzles were provided sufficient to overload the turbine greatly. This effect has already been noted.

The brake horse-power of the turbine was determined in the following manner: After the blower was tested, it was removed and a Prony brake substituted, which was loaded until the steam gage below the governor valve registered the same pressure as during any one of the blower tests. The speed and number of turbine nozzles open were also adjusted to the conditions existing during each of the blower tests. This method of obtaining the brake horse-power and the efficiency of the blower was similar to that employed by Professors Kent and Denton recently when testing a number of De Laval centrifugal pumps at these works. Since nozzles under the conditions of these tests are very accurate steam meters, the quantities of steam corresponding to the measured brake horse-powers could be determined by comparison with the steam pressures in the fan tests.

CALCULATION OF RESULTS.—In order to obtain accurate results for comparison when testing blowers, it is particularly necessary to make observations of the atmospheric pressure and temperature of the air, and also of the moisture it contains, although under ordinary conditions of the atmosphere the latter will not affect the results very materially.

PERFORMANCE TESTS OF 20-H.P. DE LAVAL STEAM TURBINE AND STURTEVANT BLOWER, NO. 7 (SPECIAL).

Time of Test.	Steam at Gov. Valve in lbs Above	Steam at Gov. Valve in lbs Below	Temp. of Steam. Deg. F.	Total Steam used by Turbine. lbs. per hour.	Speed of Gear Shaft per min.	Steam Nozzles open. No.	Psychrometer Readings, Temperature in Deg. F. Wet.	Psychrometer Readings, Temperature in Deg. F. Dry.	Temp. of Air in Box. Deg. F.	Barom. Press. Ins.	Diam. of Air Nozzle. Ins.	Pressure, ins. Water. Air Box.	Pressure, ins. Water. Pitot Gauge.	Quantity of Air Discharged in Cu. ft. per min. Formula.	Quantity of Air Discharged in Cu. ft. per min. Pitot Read.	Air Horse-Power. Formula.	Air Horse-Power. Pitot Read.	Brake Horse-Power.	Efficiency of Blower. Per Cent. Form.	Efficiency of Blower. Per Cent. Pitot Read.	Steam Used Per. Air H. P. Hour. Form.	Steam Used Per. Air H. P. Hour. Pitot Read.
Test No. I.—4-in. Air Nozzle.																						
4.45	101.75	59.25	.....	.....	2010	....	73.	86.5	....	.....	.....	19 1/2	19 1/2	.....	.....	.....	.....	.....	.....	.....	.....	.....
.50	101.75	58.8	.....	.....	2020	....	72.5	86.	....	.....	.....	19 1/4	19 1/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.55	101.75	59.25	.....	.....	2015	....	72.7	86.5	....	.....	.....	19 3/4	19 1/2	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.00	101.75	....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aver..	101.75	58.75	335.5	752	2015	2.5	72.9	86.5	98.6	29.91	4-in.	19.78	19.85	1584.7	1585	4.87	4.88	11.625	41.89	41.97	154	153.8
Test No. II.—5-in. Air Nozzle.																						
2.20	101.75	65.5	.....	.....	2020	....	76.	87.5	....	29.91	.....	19 1/2	19 3/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.25	101.75	65.	.....	.....	2025	....	75.	88.5	....	.....	.....	19 3/4	19 5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.30	101.75	64.5	.....	.....	2022	....	75.	88.	....	.....	.....	19 7/8	19 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.35	101.75	64.5	.....	.....	2021	....	75.4	88.	....	.....	.....	19 7/8	19 7/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.40	101.75	64.5	.....	.....	2025	....	76.	88.	....	.....	.....	19 7/8	19 7/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aver..	101.75	64.5	351	810	2023	2.5	76.	88.	100	29.91	5-in.	19.47	19.4375	2475.9	2456.2	7.63	7.51	14.625	51.17	51.35	106	107.8
Test No. III.—6-in. Air Nozzle.																						
3.25	101.75	68.75	.....	.....	2030	....	74.	88.	....	.....	.....	19 1/8	18 7/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.30	101.75	68.75	.....	.....	2028	....	73.5	87.5	....	.....	.....	19	18 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.35	101.75	68.75	.....	.....	2035	....	73.	87.6	....	.....	.....	19	18 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.40	101.75	68.75	.....	.....	2009	....	72.7	87.	....	.....	.....	19	18 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.45	101.75	68.75	.....	.....	2040	....	72.5	87.	....	.....	.....	19	18 7/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aver..	101.75	68.75	343	854	2033	2.5	72.9	87.4	100	29.9	6-in.	19.31	13.845	3511.7	3512.9	10.42	10.43	16.875	61.7	61.8	81.9	81.7
Test No. IV.—7-in. Air Nozzle.																						
4.05	101.75	74.7	.....	.....	2042	...	72.	86.5	....	.....	.....	18 1/8	18 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.10	101.75	74.2	.....	.....	2042	....	72.5	87.	....	.....	.....	18 1/8	18 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.15	101.75	74.2	.....	.....	2045	....	72.5	87.	....	.....	.....	18 1/8	18 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.20	101.75	73.7	.....	.....	2040	....	73.2	87.5	....	.....	.....	18 1/8	18 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.25	101.75	73.7	.....	.....	2042	....	73.	87.7	....	.....	.....	18 1/8	18 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aver..	101.75	74.	348	906	2042	2.5	72.65	87.15	100	.....	7-in.	18.71	18.175	4656.9	4659.	13.3	13.38	19.625	67.8	68.2	68.1	67.7
Test No. V.—9-in. Air Nozzle.																						
9.25	101.75	90.	.....	.....	1980	....	74.5	82.5	....	.....	.....	16 7/8	15 5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.30	101.75	90.75	.....	.....	1990	....	73.3	83.3	....	.....	.....	16 1/2	15 1/4	.....	.....	.....	.....	.....	.....	.....	.....	.....
.35	101.75	90.75	.....	.....	1990	....	74.	83.	....	.....	.....	16 3/32	15 3/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.40	101.75	90.	.....	.....	1995	....	73.7	83.7	....	.....	.....	16	15 3/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.45	101.75	89.7	.....	.....	1995	....	75.	83.7	....	.....	.....	15 7/8	15 3/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
.50	101.75	89.7	.....	.....	1975	....	73.7	83.7	....	.....	.....	15 7/8	15 3/8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aver..	101.75	90.	335.4	1065	1990	2.5	74.2	83.5	93.8	30.02	9-in.	15.988	15.625	7051.7	7100.	17.1	17.3	28.06	61.2	62.8	62.2	60.8
Test No. VI.—Discharge Outlet Closed.																						
		51.2	335.5		2053	2.5			93.8			19.875	No discharge.									

Steam Nozzles used: No. 2, Diam. = .327 inch. No. 5, Diam. = .382 inch. Turbine was run non-condensing.

NOTE.—Tests made Sept. 26 and 27, 1904, at works of De Laval Steam Turbine Co., Trenton, N. J.

The weight of one cubic foot of air is dependent upon the atmospheric pressure, temperature and moisture, and is:

$$W = \frac{0.0807\ (p - 0.379\ h\ e)}{(1 + \alpha\ t)\ 29.921}$$

where:

0.0807 = the weight of 1 cu. ft. of dry air at 32° and at a normal atmospheric pressure of 29.921 ins.

0.379 = the percentage of vapor contained in one pound of saturated air at 32°.

p = the atmospheric pressure.

h = the relative humidity.

e = vapor pressure.

$(1+\alpha t)$ = the volumetric ratio of dry air at temperature $(32 + t)$°F. to air at 32°F.

Thus, for Test IV., where the dry and wet bulb thermometer gives H = 0.49, e = 1.287, t = 55.15, and p = 29.91, we have:

$$W = \frac{0.0807\ (29.91 - 0.49 \times 1.287 \times 0.379)}{1.11245 \times 29.921} = 0.0721 \text{ lbs.}$$

The velocity of discharge is $V = \sqrt{2gH}$ feet per second, H being the head in air column derived from the Pitot gage reading and W, and equal to the weight of one cubic foot of water divided by the weight of air and multiplied by the Pitot gage reading in feet; thus:

$$H = \frac{62.355}{0.0721} \times 1.514 = 1309.3 \text{ and}$$

$$V = \sqrt{2 \times 32.18 \times 1309.3} = 290.29 \text{ ft. per sec.}$$

The amount of air discharged per second is $Q = c\ A\ V$.

A = area of nozzle in square feet.

c = a constant for the nozzle. This constant is given by Weisbach and Grashof as 0.97 for a converging nozzle ⅝-in. in diameter. As this constant undoubtedly varies with the diameter of the nozzle, approaching 1 with increasing diameter, and as it is always difficult to determine, the test is simplified if this constant is set at 1, as has been done here.

Then for Test IV. we have $Q = .2672 \times 290.29 = 77.65$ cu. ft. per sec., or 4,659 cu. ft. per min.

The work expended upon the air is equal to the work done by the expanding air; thus: $H = \frac{V^2}{2g}$ ft. lbs., and the air horse-power when discharging Q cubic feet per second is

$$\text{A.HP.} = \frac{W\ Q\ H}{550} = \frac{W\ Q\ V^2}{1100g}$$

For the case of Test IV. this gives

$$\text{A.HP.} = \frac{0.0721 \times 77.65 \times 290.29^2}{2g \times 550} = 13.38$$

The brake horse-power corresponding to the conditions of Test IV. was found to be 19.625; thus the efficiency of the blower: E = 13.38 ÷ 19.625 = 68.2%. The total steam consumption was 906 lbs. per hour, and the steam consumption per air horse-power is 67.7 lbs. per hour.

The following formula for the velocity of discharge from a nozzle affords a check on the Pitot method:

$$V = \sqrt{2g \frac{n}{n-1} p_o v_o \left[\left(\frac{p}{p_o}\right)^{\left(\frac{n-1}{n}\right)} - 1\right]}$$

g = 32.18 ft. per second.

p_o = pressure of air outside box in lbs. per sq. ft.

v_o = specific volume of air at pressure p_o.

p = pressure of air in box in lbs. per sq. ft.

n = 1.41.

FIG. 1. NEW TRUNNION BASCULE BRIDGE OVER THE CHICAGO RIVER AT NORTH WESTERN AVE.; BRIDGE CLOSED.

Following is a comparison of the results of the two methods for determining V:

Number of test.	Velocity of air at nozzle. From formula.	Velocity of air at nozzle. From Pitot reading.
I.	302.55 ft.	302.60 ft.
II.	302.20 ft.	301.00 ft.
III.	297.10 ft.	297.20 ft.
IV.	290.15 ft.	290.29 ft.
V.	265.90 ft.	268.10 ft.

This sufficiently demonstrates the reliability of either of the two methods for determining V. The curve-sheet, Fig. 1, shows the results only as calculated from the Pitot tube readings, but in the table are also given the results calculated from the formula for V.

The results of the six tests are given in the accompanying table, and in diagram form in Fig. 1.

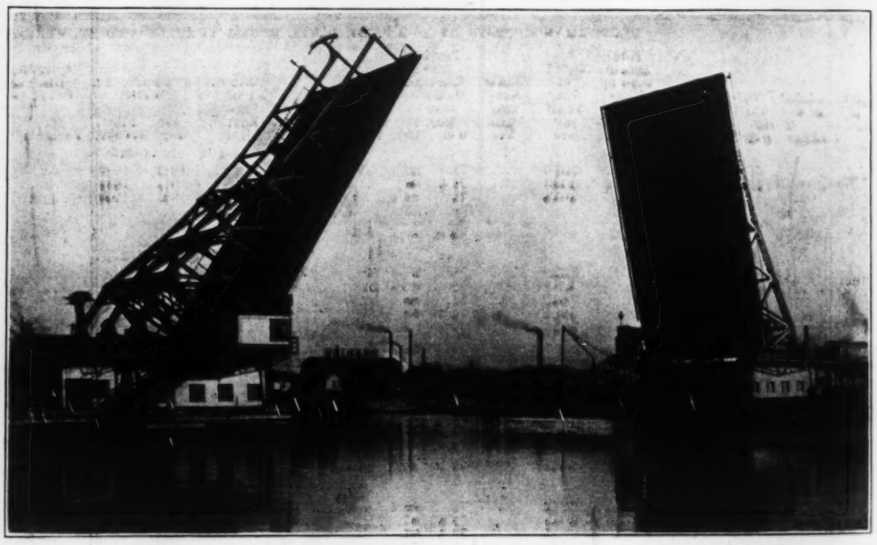

FIG. 2. NEW TRUNNION BASCULE BRIDGE OVER THE CHICAGO RIVER AT NORTH WESTERN AVE.; BRIDGE OPEN.

The diagram shows clearly that the tests were carried beyond the point of maximum efficiency of the blower.

The view Fig. 2 shows a 15-HP. blower set which is identical with the one tested, except in respect to size. The arrangement here shown, using a single blower of the Sturtevant type, is used for all sizes from 7 to 55 HP. From 55 to 300 HP., where the double-geared arrangement of turbine is used, the Sirocco type of blower is employed in blower sets, as this type has a smaller circumference for a given pressure and therefore permits placing two blowers on a common bed-plate, staggered in ground-plan to clear each other. Such a set is shown in Fig. 3, a set of 150 HP., having a capacity of 23,000 cu. ft. of free air per minute at a pressure of 21 ins. water. Fig. 4 shows the impeller wheel of the two types of blower.

The test arrangement for a smaller Sirocco set is shown in Fig. 5. This differs from the arrangement of the test described in this paper only in the different shape of air discharge box used.

Steam turbine blower sets such as are shown in the views Figs. 2 to 5 have been put in service in quite a number of gas plants throughout the country. In the manufacture of coal gas, usually two are installed in a plant, running alternately for five or six minutes at a time. The steam pipe connection is provided with a small by-pass which supplies steam enough to keep the turbine just running; the set is thus never completely shut down, which arrangement minimizes the shock when the throttle is fully opened and the load thrown on.

TRUNNION BASCULE BRIDGE AT NORTHWESTERN AVE., CHICAGO.

The city of Chicago has adopted the policy of replacing all the old swing bridges over the Chicago River with bascule bridges, thus eliminating the center piers and giving a clear and larger waterway both for navigation and to supply the Drainage Canal. While the Scherzer type of rolling-lift bascule has been adopted for several bridges built across the river by the Chicago Sanitary District, the bascule bridges built by the city are of the fixed trunnion type, as described in an article in our issue of Jan. 31, 1901, reviewing the general proposition of bridge reconstruction in connection with the improvement of the river. The latest and largest of these trunnion bridges is that crossing the river at North Western Ave., which has recently been completed, and which has a span of 205 ft. 7 ins. c. to c. of trunnion.

The old Howe truss bridge at this point, which was built in 1891, was put out of service in August, 1901, and a temporary pontoon bridge was opened for traffic in July, 1902. The new bascule bridge was designed in the Department of Public Works under the direction of Mr. John E. Ericson, M. Am. Soc. C. E., City Engineer; Mr. A. Von Babo and Mr. T. G. Pihlfeldt were the structural iron designers, and Mr. John C. Bley, designer of bridge machinery, in this department. The contract for the substructure was awarded to the Fitz Simons & Connell Co., of Chicago, on Dec. 22, 1902; work was commenced on Jan. 15 and completed on Dec. 21, 1903. The contract for the

superstructure was let to Mr. C. L. Strobel, M. Am. Soc. C. E., of Chicago, on July 15, 1903, and the shop work was sublet to the American Bridge Co. The erection was commenced April 14 and completed Nov. 19, 1904. The cost of the bridge was as follows: Substructure, $88,200; paving of approaches, $3,300; superstructure, $208,500; total, $300,000. Figs. 1 and 2 show the appearance of the bridge when open and closed.

The bridge is a through-truss structure with three lines of trusses 21 ft. c. to c., and 9-ft. sidewalk cantilevers beyond the outer trusses. The span between centers of trunnions is 205 ft. 7 ins. while the clear width of channel is 165 ft. 7 ins. between the timber protection works. On the south side there is a 17-ft. approach span from the abutment to columns on the rear wall of the tail pit. On the north side is a 75-ft. deck-truss approach span, as shown in the sectional elevation, Fig. 3. The three trunnions of each leaf are 17¼ ins. diameter and 6 ft. 10½ ins. long, each with two journal bearings 2 ft. 2½ ins. long, the bearings being carried by plate girders spanning the tail pit. The weight of each leaf complete is 1,370,000 lbs. (including the counterweight), giving about 600 lbs. per sq. in. on the trunnion bearings, under motion, for dead weight. Beneath the heel of each leaf is a counterweight of 700,000 lbs., composed of castings and pig iron embedded in cement. The plate girder floorbeams are 31½ ins. deep and carry eight lines of 15-in. I-beam stringers between each pair of trusses, two lines of stringers being spaced to carry the girder rails of the street railway tracks. The roadway has a flooring of 2¾-in. transverse oak planks spiked to yellow-pine timbers 5¾ × 3¾ ins., laid diagonally and 12 ins. c. to c. The sidewalks have transverse planks of white maple 2 × 4 ins., laid upon four lines of wooden joists 3 × 16 ins. The 75-ft. approach span has a buckle-plate floor with concrete filling and block paving. The depth of the main trusses is 13 ft. 1½ ins. c. to c. of chords at the ends, and 28 ft. 11 ins. c. to c. over the trunnion, while the headway beneath the portal bracing is 16 ft. The clear headway above the water is 16 ft. 6 ins.

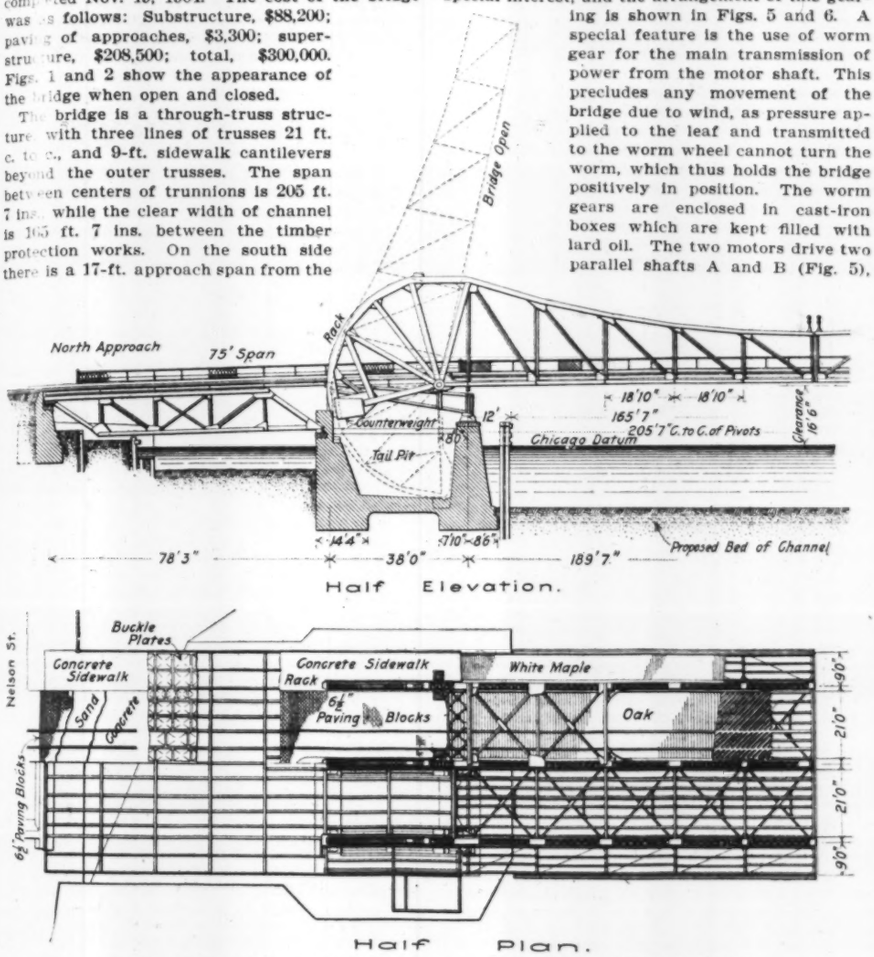

FIG. 3. PART ELEVATION AND PLAN OF TRUNNION BASCULE BRIDGE.

Each leaf of the bridge is operated by two 40-HP. electric motors, which can hold and move the leaf against a wind of 70 to 80 miles per hour indicated velocity. The segmental heels of the trusses carry the operating racks, formed of 4½-in. pins between the chord plates, as shown in Fig. 4. The pitch of the rack is 9 ins., and its radius on the pitch circle is 30 ft. 1⅝ ins. The transmission gearing between the motor shafts and the shafts of the operating pinions is of some special interest, and the arrangement of this gearing is shown in Figs. 5 and 6. A special feature is the use of worm gear for the main transmission of power from the motor shaft. This precludes any movement of the bridge due to wind, as pressure applied to the leaf and transmitted to the worm wheel cannot turn the worm, which thus holds the bridge positively in position. The worm gears are enclosed in cast-iron boxes which are kept filled with lard oil. The two motors drive two parallel shafts A and B (Fig. 5), and to equalize the power these shafts are connected by a train of equalizing gears C, D, E, F. On each shaft is a pair of worms, G, H and J, K, operating the two wheels L and M, whose vertical shafts carry the bevel wheels N and O, gearing with bevel wheels on the horizontal shafts P and Q (Fig. 6). Each of these shafts is connected by a train of spur gears, R, S, T, U, with the operating shaft V, upon which are mounted the three main operating pinions W, gearing with the racks in the heels of the trusses.

Band brakes control the operation and there is a hand gear connection for opening the bridge in case of failure of the power gear. No tail locks are required with this type of bascule bridge, and the center locks are plungers or bolt locks operated by small motors. The operating motors, brakes and locks are all controlled from the bridge tender's cabin at the south end of the bridge. The maximum travel of each leaf is through an angle of 77°.

The total length of the bridge and main approaches is 933 ft., or 1,055 ft. including the additional approaches on Nelson St. The material in the substructure comprises 4,500 cu. yds. of Portland cement concrete and 3,000 cu. yds. of rubble masonry for the curb walls of the approaches. The superstructure work comprises 1,090 tons of structural steel and iron, 700 tons of counterweight pig and cast iron, and 100 tons of machinery. The superstructure is figured for an equally distributed load of 100 lbs. per sq. ft. on both roadways and sidewalks; while the floor system and details are figured for the heaviest steam rollers and street cars, the latter weighing 22 tons empty and 35 tons fully loaded.

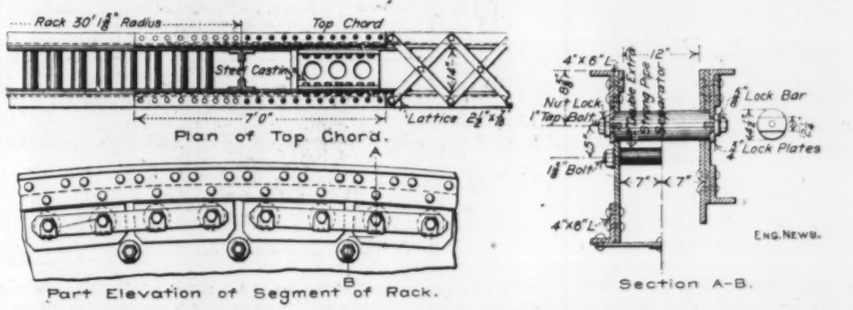

FIG 4. DETAILS OF OPERATING RACK.

THE USE AND ABUSE OF WIRE ROPE.*

By L. C. Moore.

It is thought best to confine this paper to a discussion of cast steel and the higher grades of wire rope, and it is also considered that it may prove more interesting if a short explanation of the methods of preparing wire for these grades of rope is prefixed.

Nearly 90% of all the stock of steel for rope wire is imported, in the form of either billets, wire rods, or partially manufactured wire. Steel rods for rope are always larger than No. 6 BWG (0.203-in.), owing to the comparative higher tariff on smaller sizes.

The analysis of wire rope rods for cast steel rope is:

	Carbon.	Manganese.	Silicon.	Phos. not above.	Sulphur not above.
For extra strong	.47 to .58	.20 to .30	trace	.035	.035
For plow steel...	.65 to .70	.35 to .50	trace	.035	.035

The rods are cleaned, i. e., the scale and rust, if any, removed by means of sulphuric acid diluted with say 95 parts of water which is heated to a boiling point. The coils, weighing from 60 to 100 lbs., are immersed in the tubs on wood reels and the process of cleaning usually requires about 30 minutes. They are then removed by hooks or crane and thoroughly washed with water and kept wet until they are water coated. This term is more clearly understood by the following explanation: that the rods being entirely free from scale and rust immediately commence to oxidize again and if kept wet for some time a coating forms on the surface that is afterwards utilized in drawing or reducing to the diameters required. After they have been thus prepared they are thoroughly coated with a solution of lime or whitewash, and of course further oxidization is at once prevented, provided, however, they are in the meantime carefully dried. The rods must now be baked, as during the cleaning process they have taken up a certain percentage of an element from the sulphuric acid and they can not be drawn until all of this has been eliminated, and this can only be done by baking, and requires a heat of about 400° F. and for a period of not less than ten hours. Elaborate experiments have so far not developed any superior or quicker process than that above mentioned.

The rods being ready for drawing or reducing in diameter we will, in referring to such reduction, use decimal parts of an inch as being more comprehensive than numbers, as applied to the wire gage. As before stated, they are about 0.200-in. in diameter and are first drawn to 0.150-in. — 0.155-in. This is accomplished in two reductions or drafts, one wire drawer operating two wire blocks, the first draft from 0.200-in. to 0.165-in. — 0.170-in.; the second draft reducing to 0.150-in. — 0.155-in.

In this connection the peculiar features of the wire drawing plate are considered first. They are sometimes made of what is commonly known as white cast iron, but the plate principally used is made of a special steel, and for the larger sizes perforated with 18 conical shaped holes which, owing to the peculiar nature of the metal,

*A paper read before the Mechanical Section of the Engineers' Society of Western Pennsylvania, Jan. 3, 1905.

can be opened or closed at will by the operator, who uses a hammer and a perfectly round highly tempered and polished steel punch, carefully ground to just the right taper. This requires not only skill but a knowledge of the peculiarities of the stock to be drawn; it being a fact that steel comparatively high in carbon and manganese can not be successfully drawn with the same tools as low or .08 carbon stock.

Referring again to the nature of the steel from which wire drawing plates are made, it is very low in carbon and will not take any temper. It is, therefore, soft enough to permit cutting readily with an ordinary cold

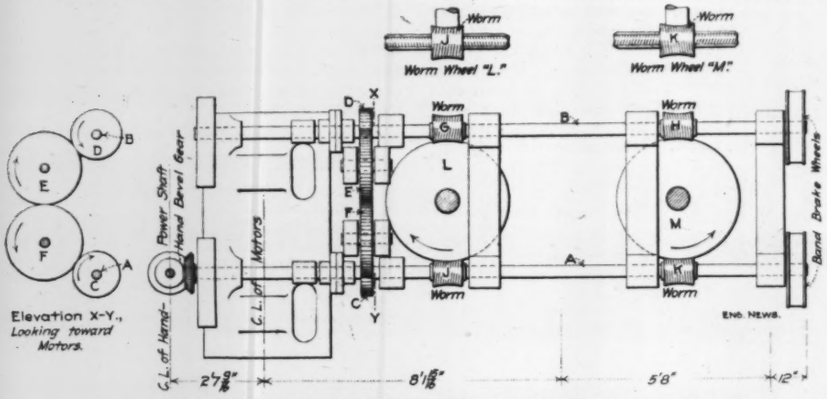

FIG. 5. PLAN OF LOWER PORTION OF OPERATING MACHINERY.

chisel, and, as before stated, the holes can be closed or opened at will without heating the plate. Yet, notwithstanding the above, steel wire rods 0.60 carbon and upwards, coils weighing even 100 lbs., and more than 1,000 ft. long, can be drawn through a properly prepared hole in a drawing plate, reducing the diameter of the rod from 0.200-in. to 0.170-in. without enlarging the hole more than 0.003-in., and this is common practice in all mills. It will be noted that this reduction necessarily hardens the stock to some extent, but does not injure it because the elastic limit has not been passed, and without any additional treatment the coil will undergo another reduction from 0.170-in. to 0.150-in. or 0.135-in.; and if the drawing plate has been properly prepared this takes place without enlarging the diameter of the hole more than 0.005-in.

By this time the steel has been hardened to such an extent that further reductions can not be made without injury until the stock has been annealed or tempered, also recleaned, coated and baked. If the former, this must be done with what is called a muffler, this being a furnace so constructed that coke, oil or gas can be used as fuel; soft coal being too high in sulphur for the purpose. The furnace must also be so constructed that no iron in the furnace lower in carbon than the stock itself comes in contact with the wire, because if so the tendency will be to decarbonize and thus injure the latter.

It follows, therefore, that a better grade of rope wire can be made by not using this form of annealing, but rather the continuous or tempering process, by which means no dangerous flames or fumes of any description can come in contact with the wire, thus preserving all the elements that are advantageous in making the best rope wire. Another feature of this latter process is: The wire being drawn into the heating tubes of the furnace from the coil, the heat of the furnace being kept at exactly the proper temperature, with careful regulation and a good pyrometer, there is no danger of injuring the wire by oxidization, because as the wire is drawn out of this furnace it is not exposed to the normal atmospheric conditions outside until cool enough so that any such contact would have no effect whatever on the stock.

After reducing the rods from 0.200-in. to 0.155-in., tempering or annealing by the continuous process, again cleaning, coating and baking the wire with even more care than the first time, the stock is now ready for a further reduction. This is accomplished in exactly the same manner as the former, the tools used being smaller in size and diameter only. Also after the first drawing and continuous annealing process it is a fact that the quality of the stock has been improved, and this being the case the wire can be reduced four or even five drafts without annealing or injury; not such a severe reduction in parts of an inch, but just as much or more proportionately to its diminished area as before. Rope wire of 0.155-in. diameter after being properly treated can be reduced to 0.097-in., after which, if further reductions are required, it should be treated in precisely the same manner as already described.

All of the various stages of reduction from 0.200-in. to 0.097-in., referred to above, have also served another purpose: that of locating flaws or points low in tensile strength. Therefore, by the time the wire reaches the inspecting and testing departments nearly, if not quite all, the inferior stock has been discovered, rejected as rope wire and to be used for some such purpose as finer or market wire.

The best quality of cast steel rope of any prescribed strength is that in which the wires of same are the most uniform in the bending and tensile strength tests. Neither torsion nor elongation as tests are of any importance in determining the quality of rope wire in the testing department. If the manufacturer, in making up a stock reel of say ⅝-in. diameter 6 x 19 cast steel rope, permits a variation of more than 5% in tensile strength and the same in bends, then this rope will not in all cases show good service, but if both tests are confined to say 2% variation in each direction, the quality of the stock reel will be perceptibly improved. All practical minds will agree that if wire is used in rope varying from 160 to 180,000 lbs. per sq. in. in tensile strength, there will be a difference in resistance to bends. Therefore, it follows that it is not always safe to depend on determining the probable life of a partly worn rope by counting the number of exposed broken wires to the foot or yard. Neither does it follow that because, say, one-half of all the wires exposed are broken that it is time to abandon its use or procure a new rope, because it may be that the factor of safety is high and we must admit that with one-half of all the wires broken the rope is more pliable than when new; and to sum up fact of one-half the wires being broken usually p that either a smaller diameter or more pliable rope sh have been purchased in the first place.

There is an impression that sometimes a rope is m with a bad spot in it running say several hundred long. This is utterly impossible, and the reason is follows: Take, for instance, a piece of ⅝-in. diam 6 x 19 cast steel rope, which would be a total of 114 w in all. Now the size of wire used for this rope weigh lbs. to the mile, and as before stated, drawing the w several different times has developed the majority of spots; and even if not, it is impossible in a mile or m of rope for these spots to come near enough togeth cause any damage, and also because it is a fact, a been demonstrated, that a test specimen with more half of the exposed wires broken has shown a t strength of 90% of the original.

It is undoubtedly a fact that more mistakes are m in buying a rope too large in diameter than too smal the service, and also in selecting one made of seven w to the strand instead of 16 or 19 wires.

Referring to six strands of 12 wires each, this sty rope should never be used except for standing or rope. Neither is there any decided advantage in the of what is known as "Lang Lay," or so-called pate ropes, except from the possible fact that the manufac ers thereof are in some instances sharp enough to use plow-steel grade of stock in so-called cast-steel rope and thus make a temporary record; and there is no know trade mark of rope that has proven itself superior to an other, and in fact the consumer must depend entirely o the honesty of the manufacturer from whom he buys h rope. He may in installing a new plant purchase a rop from "A" and when same is worn out buy another from "B." Now it may be possible that the second rope do not give as good service as the first one, therefore, he makes his third purchase from "A" again; and this rope may give more unsatisfactory service than the first rope from "A." Usually this can be explained by the fact that the plant, that is, the sheave wheels, have not been kept in as good order as when first installed, or possibly the tonnage has been increased. Still the consumer of wire rope is not always at fault. It more frequently happens that the dealer or agent who sells the rope unintentionally makes a mistake in case the customer is not posted and recommends a style not exactly suited for the purpose. This possibility is gradually decreasing, owing no doubt to the fact that profits on sales are gradually being reduced, and there are not so many dealers in or agents for wire rope as formerly.

As to the matter of claims for defective rope the manufacturer in making a stock reel usually keeps a record of same and at any length of time afterwards it is possible to ascertain to whom each and every piece of this rope was sold. Now if this reel originally contained 20,000 ft. and was cut up and sold to say eleven different customers, ten of whom keep quiet and the eleventh customer complains, it is hardly possible for him to prove his claim.

Too much cannot be said regarding the care of wire rope. It requires lubrication just the same as high speed journals. Of course, conditions usually prevent any such treatment, but to insure the best results the rope, if made to order, should be thoroughly lubricated when the strands are being laid up into a rope; and if so treated and afterwards kept well saturated on the outside with any kind of cheap lubricant that is free from acids, good results are bound to follow. The same diligence should be exercised in looking after all sheave wheels. They should be balanced, or as nearly so as is possible, bored true with deep wide flanges and the grooves kept lined with Russia hemp or other fibrous material. It is not good practice to run wire rope in chilled iron grooves, or even cast iron grooves, but if iron must be used, either a low steel or wrought iron lining should be specified for the grooves.

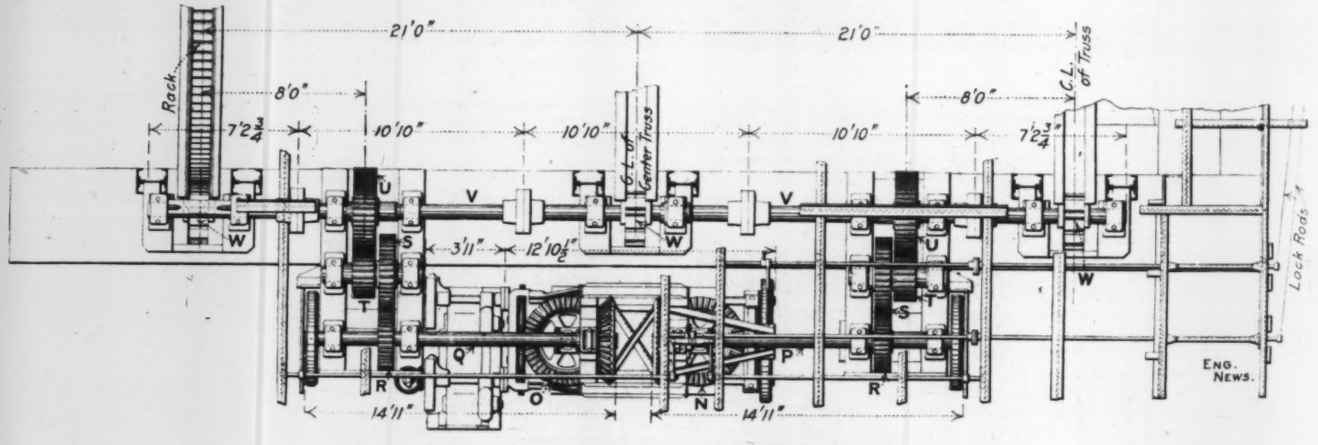

FIG. 6. PLAN OF UPPER PORTION OF OPERATING MACHINERY.

SANITARY REGULATIONS GOVERNING CAMPS IN THE U. S. RECLAMATION SERVICE.

By M. O. Leighton.*

The maintenance of sanitary regulations is always governed by local conditions. While it may be possible and practicable to enforce a refined sanitary code in municipalities provided with public water supply, sewerage and garbage disposal, regulations for less fortunate communities must be adjusted to correspond with the possibilities at hand. In other words, it would be futile to attempt to force upon the inhabitants of a primitive village in an up-state county health ordinances based upon the civic improvements of a place like New York City. This principle is positively demonstrated when it becomes necessary to enforce hygienic rules upon a construction camp.

Engineers have exceptional opportunity to discover that a man's physical condition is the measure of his day's work. Sanitation in construction camps is usually as important as steam or electric power, yet by reason of devious and uncertain conditions which are met upon every construction project it is usually quite difficult to wisely select the special subjects for regulation. The personal habits of laborers in camp can be controlled only in so far as they may affect the remainder of the camp. The utmost that can be accomplished is to surround them with the best sanitary influences possible under the controlling conditions and to enforce certain community rules. The problem arises in determining just which rules are demanded by the special conditions in each case. The engineer upon one job may find that the greatest problem is the disposal of waste; upon another he may be obliged to search diligently for a wholesome water supply; in the arid regions he may be obliged to accept the only water available and, disregarding its quality, be thankful that its quantity is sufficient.

The U. S. Reclamation Service has been obliged to consider the hygienic features of construction camps in connection with the vast irrigation work now being carried on in the West. Large bodies of men of every description are gathered together upon the various projects. Frequently they are located many miles from civilization, in the open, free, western country. Each man there is an individual rather than a cog in a gear. He will cheerfully bear restraint only to a certain definite line, which, in his opinion, divides his allegiance to his employer from his God-given prerogatives. These personal peculiarities, together with a lack of facilities of every description common to a border country, make the enforcement of sanitary regulations largely a matter of good judgment and expediency. The sanitary code which has been provided is the result of considerable study, and while it may appear somewhat crude when compared with similar regulations enforced in the East, it is believed to be altogether the best which can be devised under the circumstances.

Each contract executed for construction work contains the following clauses:

SANITATION.—The Chief Engineer may establish rules for sanitation and police regulations for all forces employed under this contract; and should the contractor fail to enforce these rules, the engineer may enforce them and assess against the contractor the cost thereof, which will be deducted from any sum due on the contract.

USE OF LIQUOR.—The use and sale of intoxicating liquor will be absolutely prohibited on the work except under the direction and supervision of the engineer or his agent, and then only for medicinal purposes.

From the above it may be seen that there is no attempt to interfere with the use of intoxicants by the laborers after they have completed their day's work and departed from the premises. Such action has been found to be futile in the East; in the West it would be highly absurd.

The following is the sanitary code enforced by the Engineers in Charge of Construction under the U. S. Reclamation Service:

CAMP SITES.—Especial care should be exercised in the location of camp sites. They should be placed upon well-drained ground where sun and air may have free access and as far as possible from bodies of quiescent water, such as bog holes, seepage ponds and sinks. Low places along river bottoms should be avoided whenever possible, and in case it becomes necessary to establish a camp at any point where the ground water table is close to the surface, each camp structure should be surrounded at its base by a trench of from 1 to 2 ft. in depth and an outlet provided for emergency use to drain off water which may collect there.

CAMP STRUCTURES.—Camp sites should always be selected convenient to some source of water supply, but the camp structures should not be placed in close proximity thereto. The slope and nature of the soil should be considered and no structure should be erected at a point from which effete matter may filter through the ground and infect the water supply.

LAVATORY ARRANGEMENTS.—Arrangements should be made for the rapid and complete disposal of water from wash basins, tubs, etc. In the case of permanent camps a sink should be provided with pipe connection to a covered cesspool located at a point from which there will be no drainage to a well or other stored water supply. Whenever the conditions are such as to make this arrangement impracticable the lavatory should be placed at a point similar to that described in the case of the cesspool. Where the nature of the ground is not such as to readily absorb all wash water an excavation of proper dimensions should be made and filled with loose material to a level with the ground surface.

WATER SUPPLY.—The water supply for all camps, especially that used for drinking and cooking, should be absolutely free from all suspicion of dangerous organic contamination. Old wells in questionable positions with reference to surface or outbuilding drainage should be avoided and wherever there are no wells free from such suspicion upon the site of a permanent camp new ones should be sunk at unquestionable points. Whenever it is necessary to erect a camp at which the only water available is open to suspicion or is known to be contaminated with animal wastes, such water should be purified by boiling or by filtration. If the former course is taken, great care should be exercised to maintain at all times a sufficient quantity of stored water which has been cooled after boiling. In many cases where boiling has been resorted to for water purification, this rule has not been observed and the members of the camp, finding no water or only that recently boiled, have been induced to drink raw water. Such an act destroys the value of all previous precautions. Filtered water is far more palatable and generally as safe as that which has been boiled. The Berkefeld filter is the one best adapted for such uses. It can be provided in various sizes and should be installed with a suitable container to store filtered water. The pressure should be developed either by pumping direct through the filter or by placing a small reservoir at some point higher than the filter and allowing the filtration process to go on continuously into the clear water reservoir.

FLIES AND MOSQUITOES.—The most important sanitary provision in connection with camps is that of exclusion of flies from cook tents, mess tents and privy vaults; yet this is the very provision which is most frequently overlooked. According to the report of the commission appointed by President McKinley to investigate into the occurrence of typhoid fever among the soldiers during the Spanish war, almost every outbreak which occurred was due to the lack of sufficient protection against flies. Therefore, special care should be taken to exclude flies from all places in which foodstuffs are exposed, and, if necessary, in the large camps a man should be detailed to accomplish this purpose.

Mess and cook tents or houses should be provided with screens at all windows and each door, which leads into the outer air, should be provided with a vestibule about 4 ft. sq., constructed in the following manner: The dividing partition and the door between the cook or mess tent and the vestibule should be of wood as well as the side walls of the vestibule for a distance of about 1 ft. from the dividing wall. The door and walls should be painted black or some dark color; the remainder of the vestibule should be of durable wire netting and the door leading from the vestibule out, of the same material. With such a provision the flies which enter the outer screen door during the time when people are passing through, will be caught in the vestibule and will congregate upon the wire part of the vestibule in preference to the dark colored wood next to the cook or mess tent, and only a very small proportion of the flies entering the vestibule will under such conditions escape into the larger apartment. If the cook and mess tents or houses are not built under a common roof, the passage between the two should be thoroughly screened, and if an entrance is made from the outside to the passage, vestibules should be provided as above described.

Of equal importance is the thorough screening of privy vaults and vault apartments, for it is from such places that flies, carrying upon their bodies effete material, diffuse throughout the camp an epidemic by coming in contact with foods. Without proper screening a disastrous epidemic of typhoid may be easily spread through a camp if one of the members of the camp—or, indeed, a transient guest—should be in the prodromal stages of the disease. It is at these times that the discharges are most virulent. Vaults should, therefore, be built of tight material and be provided with a vestibule at the entrance similar to that above described in the case of cook and mess apartments.

Wherever it is possible to do so, sleeping apartments should be thoroughly screened, not only for the comfort of the members of the camp, but to protect them from mosquitoes which transmit the malarial infection. The genus anopheles, which transmits the malarial infection through its proboscis, does not commonly fly about during the day, but is active at night and should be excluded from sleeping apartments.

Camps should be well supplied with sticky fly paper in cook and mess apartments, and all flies, mosquitoes, etc., should be excluded so far as it is possible to do so before foodstuffs are exposed.

GARBAGE.—Garbage should not be allowed to remain upon camp premises for any length of time, but should be removed as frequently as conditions will allow. While it is necessarily stored upon premises, it should be kept in metal containers and protected from flies and other vermin.

Privy vaults should always be placed at a considerable distance from other camp structures, should be kept as dry as possible and should not be so placed that the drainage therefrom will infect the local water supply.

*Chief of the Division of Hydro-Economics, Hydrographic Branch, U. S. Geological Survey.

ANNUAL CONVENTION OF THE INDIANA ENGINEERING SOCIETY.

The 25th annual convention of this society was held in the rooms of the Commercial Club at Indianapolis, on Jan. 12, 13 and 14, but the attendance was not very large. The report of the Secretary, Mr. C. C. Brown, showed that the Society has now 120 members, and that the expenses for the year practically equaled the receipts.

TECHNICAL EDUCATION.

The address of the President, Prof. R. L. Sackett, of Earlham College, discussed the subject of the relation of the engineer to national development, more particularly in regard to the use of steam power and machinery. In regard to technical education he approved of government assistance in research which is too extensive for private capital, and stated that Germany maintains its position in industries involving technological chemistry largely through the work of its government experts. We quote Prof. Sackett's concluding remarks as follows:

There is a notion prevailing amongst those who go to technical schools, and in some who graduate, that the only requirement of an engineer is highly specialized technical knowledge. We need to see more clearly that character stands entirely above technology. A dishonest engineer is a menace to public and private enterprise. The average technical student is immature, and incapable of giving proper weight to much of the advanced theory which he receives. It will be a fortunate day when the latter is reserved for post-graduate study. More desirable is thorough training in lower mathematics, in economics and in science. A broader foundation will give us an engineer of wider knowledge, sympathies and tastes. But above all the position which the engineer occupies as arbitrator, a judge of design, cost, construction and operation requires that he shall be unprejudiced, fair-minded and of highest integrity, and after that an expert in his business. Technical education must enforce the responsibility of the engineer to society as well as to his client.

STREET PAVING.

A short paper on "Pavements" was presented by Mr. J. W. Fulwider, of Lebanon, opening with a statement as to the necessity of proper drainage in obtaining economical maintenance of country roads. As to street paving, he thought that nothing but brick should be recommended for the smaller cities, and doubted whether the noise from such pavements would be objectionable. For sidewalks, however, he preferred concrete. In the construction of a 60-ft. street in a residence district he has used a 20-ft. paved roadway and concrete walks 5 ft. wide, with a 1-ft. space between the walk and the property line. The crown of the street is level with the curb, and there is a gutter 4 ins. deep. The street intersections are level, with inlets connected to a 10-in. storm-water sewer, and a 6-in. tile drain is laid the entire length of the work 2 ft. below the sub grade. The narrow roadway is sufficient for its purpose, and reduces the expenses for repair, cleaning and sprinkling. The objections to it are becoming less. A concrete base is the best for brick pavements, and a base 4 ins. thick is ample in the smaller cities. Local organizations or civic leagues can do much to improve the "park-way" between the walk and the roadway and to compel the city authorities to keep the street clean.

The report of the Committee on Roads and Pavements expressed the opinion that gravel and macadam are not durable for city streets. In

securing good paving brick, the City of Columbus, O., selects 20 to 60 of the best brick as delivered on the street and tests them according to the standard tests of the National Brickmakers' Association. If the loss in the rattler is over 18% the bricks are rejected (few lose less than 13%). As the loss in such cases usually falls on the manufacturer, one company has put in its own rattler and only sends to Columbus such brick as will pass the test. If other cities would follow this practice there would be less trouble from poor brick. It is very desirable that there should be some method of testing asphalt which can be applied in small towns and on short notice, without waiting a week or two for a chemist's report, while all the time the contractor is laying the asphalt. The committee recommended that this matter be taken up by the Society.

STANDPIPES AND WATER TOWERS.

Prof. R. L. Sackett presented a paper on "Designs for a Protected Standpipe." The standpipe in question had to harmonize in appearance with a group of buildings of a public institution, and for this and other local conditions (including requirements for protection from the formation of ice and for a minimum of expense for painting and repair) a standpipe enclosed in a masonry tower was adopted in preference to an elevated tank and water tower. The standpipe is 16 × 100 ft., with a minimum head of 50 ft., but in an emergency, of course, the lower body of water can be drawn upon. The tower is of concrete with inside and outside facing walls of brick connected by iron ties. A concrete core and cylindrical wall connected by a floor of reinforced concrete form the foundation, supplemented by radial walls.

WATER POLLUTION AND FILTRATION.

At the evening session, Mr. W. D. Collins presented a paper on "The Pollution of White River from Muncie to Anderson," showing the deplorable results due to the existence of strawboard factories, slaughter houses, rod mills, privies, stables and other sources of pollution along this stream. He also described the methods of the Metropolitan Water Board in protecting the purity of the water supply of Boston, Mass. This was followed by a paper on "Progress in the Filtration of Public Water Supply," by Mr. Charles Brossman, Jr. This described rapid or mechanical filtration and slow sand filtration, giving a number of styles of underdrains used in the latter, including a triangular tile pipe designed by the author.

REINFORCED CONCRETE CONSTRUCTION.

At the evening session of Jan. 12, Mr. Daniel B. Luten presented a paper on "The Design of Concrete Arches," with formulas for use in the design of arches on his patented system, where an invert with steel rods is connected to the abutments and forms a tie. This system was described in our issue of May 8, 1902, and over 250 arches of 3 ft. to 95 ft. span have been built.

The report of the Committee on Materials of Construction, presented at the morning meeting on Jan. 13, also dealt largely with reinforced concrete. It showed that the results of tests of about 40 beams at Purdue University bear out Mr. Condron's idea that the strength of a beam is a straight line function of the amount of steel embedded within it. Early in the history of reinforced concrete it was stated by Mr. Considère, of France, that the extensibility of reinforced concrete was at least ten times that of plain concrete. The deduction is that the steel may be used up to its elastic limit in the tension side of a beam before the mortar surrounding the steel will crack. Tests made by Prof. Turneaure showed that fine cracks appeared in the concrete at stresses in the steel corresponding to 2,000 or 3,000 lbs. per sq. in. Tests by Prof. Talbot indicate that at a stress in the steel of about 3,000 lbs. and about 250 lbs. in tension in the extreme fiber of the concrete, the steel is suddenly elongated as if the concrete in tension had given way and thrown its share of the load on the steel, but no cracks are visible to the naked eye at this stage. Tests made at Purdue University on beams of concrete containing crusher dust and allowed to harden under a cover of sand, showed a much higher flexibility than the tests of either Prof. Talbot or Prof. Turneaure. This might have been expected in view of the effect of crusher dust in increasing the flexibility of concrete. Beams which were reinforced deflected about ten times as much as beams not reinforced before cracks appeared.

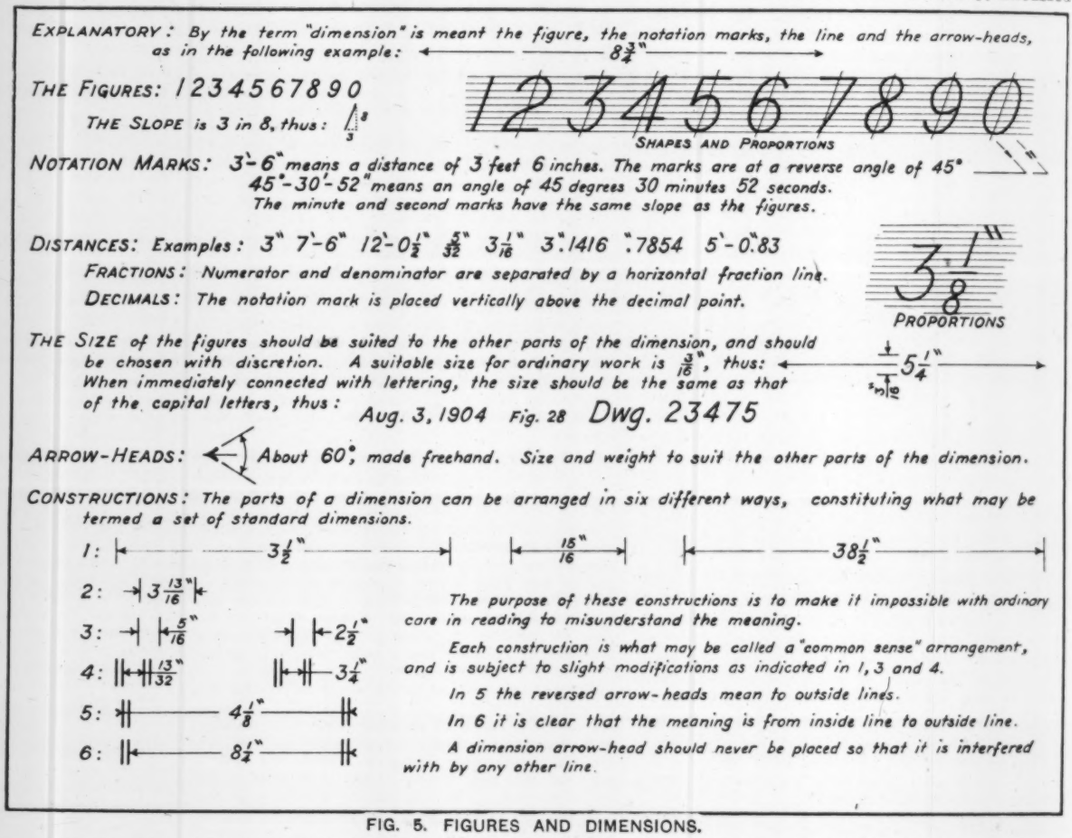
EXPLANATORY: By the term "dimension" is meant the figure, the notation marks, the line and the arrow-heads, as in the following example: 8¾"
THE FIGURES: 1234567890
THE SLOPE is 3 in 8, thus:
1234567890
SHAPES AND PROPORTIONS
NOTATION MARKS: 3'-6" means a distance of 3 feet 6 inches. The marks are at a reverse angle of 45°
45°-30'-52" means an angle of 45 degrees 30 minutes 52 seconds.
The minute and second marks have the same slope as the figures.
DISTANCES: Examples: 3" 7'-6" 12'-0½" 5/32" 3 1/16" 3".1416 ".7854 5'-0".83
FRACTIONS: Numerator and denominator are separated by a horizontal fraction line.
DECIMALS: The notation mark is placed vertically above the decimal point.
3 1/8"
PROPORTIONS
THE SIZE of the figures should be suited to the other parts of the dimension, and should be chosen with discretion. A suitable size for ordinary work is 3/16", thus:
5 1/4"
When immediately connected with lettering, the size should be the same as that of the capital letters, thus:
Aug. 3, 1904 Fig. 28 Dwg. 23475
ARROW-HEADS: About 60°, made freehand. Size and weight to suit the other parts of the dimension.
CONSTRUCTIONS: The parts of a dimension can be arranged in six different ways, constituting what may be termed a set of standard dimensions.
1: 3½" 15/16" 38½"
2: 3 13/16"
3: 5/16" 2½"
4: 13/32" 3¼"
5: 4⅛"
6: 8¼"
The purpose of these constructions is to make it impossible with ordinary care in reading to misunderstand the meaning.
Each construction is what may be called a "common sense" arrangement, and is subject to slight modifications as indicated in 1, 3 and 4.
In 5 the reversed arrow-heads mean to outside lines.
In 6 it is clear that the meaning is from inside line to outside line.
A dimension arrow-head should never be placed so that it is interfered with by any other line.

FIG. 5. FIGURES AND DIMENSIONS.

In the discussion, Mr. Luten suggested that as the adhesion of concrete to steel is greater than the shear of concrete, shear would occur before slipping when any but round bars are used. Prof. Pence stated that this would be covered by the factor of safety. Bars which are corrugated or have any mechanical hold upon the concrete are of higher grade steel than the common round bars obtainable in the open market, but Mr. Luten thought that even so it might be more economical to use ordinary round bars at 1½ cts. per lb. than special bars at 2½ cts., the former being also more readily obtainable.

The report of the Committee on Bridges and Masonry presented a set of specifications and plans for the substructure and superstructure of a bridge over the Scioto River, as prepared by Mr. Walter Braun, County Engineer.

Mr. V. H. Lockwood presented a paper on "Patent Law," relating largely to the question of infringements. The Secretary read a paper by Mr. G. E. Smith, of Philadelphia, Pa., on "Shipbuilding," being a review of the procedure in the design and construction of naval vessels. The report of the Committee on Mechanical Engineering briefly reviewed a number of subjects, including technical or trade schools, central stations for heating and lighting, and smokeless firing of boilers. In Indianapolis, boilers are not usually worked above their capacity, but the policy for future installations must be along the following lines: ample grate area, high chimneys, larger combustion chambers, firebrick cooking chambers in which to burn the coal, and correct ratios between grates, heating surface, breechings and chimneys.

In the afternoon of Jan. 13 there was an excursion to the Falls Creek bridge of reinforced concrete, now under construction, and then to the new filter plant and new pumping engine of the Indianapolis Water Co. At the evening session three papers were presented, all illustrated by stereopticon views. Mr. O. E. McMeans described "A Modern Flour Mill," being a mill at Buffalo, N. Y., which is operated by electricity; it has a 400 HP. motor with a 14-rope transmission system. Prof. F. B. Ernst, of Purdue University, described. "The Westinghouse Air Brake," and Prof. E. W. Kerr, of Purdue University, discussed "Various Methods of Developing Gear Teeth," including gear-cutting machines.

LAND DRAINAGE IN INDIANA.

On Jan. 14, Prof. W. D. Pence, of Purdue University, described the topography and drainage system of the State of Indiana (which has seven drainage areas), and referred to the investigations now being made by him in regard to agricultural drainage of the State, for the irrigation and drainage bureau of the U. S. Department of Agriculture. This will cover the extent and methods of drainage, its effects upon crop production and public health, and also the manufacture of drain tile and the use of ditching machines. In some cases, levees and dikes have been built to protect areas of land from flooding. In the discussion the trouble due to sand and gravel being carried into the main ditches by small streams was referred to, and the construction of dams was suggested for the purpose of holding the sediment back in the laterals. This has already been done in some cases. In one case where the fall was so severe as to cause serious wash, dams were put in to reduce the hydraulic gradient, and so check the velocity and cause the sediment to

settle. This discussion was followed by a brief paper on "Farm Drainage," by Mr. Lewis B. Alter. Mr. J. S. Spiker read a short paper on "Resurveys of Land in Knox County," and there was also a paper by Mr. J. W. Fawcett on "The Land Surveyor." The report of the Committee on Railways noted some of the work done in the State during 1904, and referred to the use of the single-phase system on the Rushville Division of the Indianapolis & Cincinnati Traction Co. The last paper was by Mr. John Finan, Jr., on "Municipal Improvements under the Artman Law," referring particularly to work done at Connersville, Ind.

OFFICERS.

The election of officers resulted as follows: President, R. P. Wood; Vice-President, W. F. M. Goss. The Secretary and Treasurer is C. C. Brown, of Indianapolis. The next meeting will be held at Indianapolis, Ind., in January, 1906.

A PROPOSED UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.*

By George H. Follows.†

Part III.—Figures and Dimensions.

35. In the average mechanical drawing the dimensions play the principal part, not only because they directly guide and control the work in the shop, but because many of them—what are generally termed the *working* or *finish* dimensions—have to play an active part during the entire life of the drawing.

36. By the term dimension as used here is meant the complete construction—the figure, the notation marks, the line and the arrow-heads.

37. I would lay particular emphasis upon the fact that a working dimension is "alive" as long as the drawing is in use; so that if it is difficult to read, doubtful, or misleading, when the drawing is first made, it is again difficult to read, again doubtful, or again misleading every time it is referred to. Thus an indistinct arrow-head or a 3 that looks like an 8 is in the first place a possible source of error, and if allowed to remain may become a permanent source of trouble and expense.

38. Every dimension should indicate with unmistakable clearness two things: First, the points or surfaces between which measurement is to be made; second, the distance to be measured. These are the chief requirements.

39. Fig. 5 deals with the several parts of a dimension, and shows a set of six standard constructions.

40. THE FIGURES.—The figures in a drawing, like the letters, should be entirely free from ornamental or superfluous features, so that they may be both easy to read and easy to write. Those given have the required simplicity of construction without being in any way robbed of their individuality, and the shapes are such that it is practically impossible to mistake one figure for another.

41. What was said in paragraph 34 about the use of sloping lettering applies here to the sloping figures. If sloping lettering is adopted, sloping figures should also be used.

42. NOTATION MARKS.—The peculiarity of the notation marks for the foot and inch is that they are sloped in the opposite direction to the figures. This is done to make it less possible for a mark to be confused with the figure 1, especially in connection with the numerator of a fraction. Incidentally this reversing of the marks gives additional character to a dimension.

43 FRACTIONS.—The writer is of the opinion that the horizontal fraction line is better than the sloping one, not only because it is less likely to be scribbled, but because it makes a neater looking and more compact fraction.

44. DECIMALS.—The position of the notation mark is of importance. Placed as shown, it is a valuable check on the decimal point.

45. CONSTRUCTIONS.—The clearness of a dimension depends largely upon the disposition of the arrow-heads and dimension lines with respect to the lines representing the points or surfaces of measurement. The constructions given will bear careful study. They are not by any means an insignificant part of the language of mechanical drawing.

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†Of the Engineering Department, Westinghouse Electric & Manufacturing Co., The Park View, East Liberty, Pa.

STORAGE BATTERIES FOR BLOCK SIGNAL WORK.*

By Edward L. Reynolds.

Within the past few years the attention of signal engineers has been turning with greater concentration towards the best method of supplying signaling and interlocking devices with electric current, and the result is indicated by the rapid increase in the use of storage cells for this purpose.

With storage batteries it is necessary to provide a charging source. Consequently provision must be made either for carrying the charging current to the batteries over a transmission line (the batteries being placed permanently at the working points), or the batteries must be of portable form and transported to and from the charging station. These two methods, therefore, in general cover the means of storage battery operation. Which method shall be adopted in any given case is obviously dependent upon the geographic distribution of the devices to be served. In the case of transmitting the current to the battery points for recharging, we have the additional investment in the transmission line, the extra power required to compensate for the line loss, a greater number of cells than required for portable work and a somewhat larger generator. In the portable plan, on the other hand, we have a somewhat more expensive form of battery, due to the fact that it is necessary to install a larger size of cell and to use rubber jars instead of glass. In addition to this, we have in some cases the extra expense of transporting the cells. In deciding, therefore, which method shall be used, a careful comparison of these various items should be made.

SOUTHERN PACIFIC CO.—This road has been using storage batteries in signal work for several years, and Mr. Slater has very kindly contributed a great many interesting facts relative to this work. Between Truckee, Cal., and Spark, Nev., there are 66 automatic signals operated from 41 battery locations. Each battery set consists of four Exide cells having a capacity of 55 ampere hours and 8 volts. These four cells are mounted in two wooden cases, two cells to each case, handles being provided, so that they can be readily transported. Each case of cells weighs approximately 25 lbs. These four cells, connected in series, are used for one signal, or for a pair of signals, provided they are not a greater distance apart than 500 ft. Once a month the cells are placed upon a car and returned to the charging station, inspected and re-charged. It is customary to charge these cells in sets of seven, four cells to each set, making 28 cells in all. These batteries, when recharged, are then distributed to new locations and exchanged for other cells which have been in use for a month. The charging station upon the division shown is at Truckee. The foreman makes his headquarters at this point and has under his control the charging station. This entire division of approximately 38 miles has four signal maintainers in addition to the foreman.

Since there are 41 locations, with four cells at each, this makes a total of 164 cells supplying 66 signals, or approximately 2½ cells in operation per signal. Ordinarily 56 extra cells are kept in the charging station to exchange for others when they become discharged, so that the total number of cells for the normal operation of this section of the road would be 220, or 3⅓ cells per signal; or approximately six cells per mile of track. It is estimated that it costs 10 cts. per KW. hour for charging the batteries, which is less than $1 for each set of four cells per year, or $55 per year for the total number of 55 sets. The cost of the charging station is approximately $300. This figure is exclusive of the building. In general, a small charging plant can be placed in a portion of a building already constructed and used for other purposes. A gas engine is used to drive the generator.

On this section of track, with 66 signals, if primary cells were used it would be necessary to have 16 cells for each signal, because it is not practicable to connect two signals to one set of primary cells, consequently for the 66 signals 1,056 primary cells would be required. The cost of these cells is in the neighborhood of $2.50 each delivered on the Coast, and the cost of material for maintaining the same is reported as $1 per cell per year; or a total fixed maintenance expense of $1,056 per year. The maintenance of the storage battery plates for this entire section is estimated at $200 per year. The first cost of the 220 Exide cells will be approximately $1,200. A comparison, therefore, of the first cost and operating cost will appear as follows:

FIRST COST.

1,056 Primary cells at $2.50	$2,640.00
Cost per mile of single track	60.50
220 Storage cells	1,200.00
Charging plant	300.00
Total	$1,500.00
Cost per mile	$ 39.50
Increase in first cost of primaries over storage	75%

MAINTENANCE COST.

Maintenance on 1,056 primaries for one year	$1,056.00
Maintenance per mile	27.80
Maintenance on 220 storage cells for one year	200.00
Charging current for one year	55.00
Total	$ 255.00
Maintenance per mile	$ 6.70
Increase in maintenance cost of primaries over storage	317%

The above figures show the relation between the operating costs of the two methods, since labor is the same in both cases.

The question of first cost and operating expense having been settled in this instance to the marked advantage of the storage battery, it remains to be determined whether the storage battery system possesses any points of advantage in actual operation. One point that impresses the engineer immediately is the fact that four cells of storage battery replace 16 primary cells, and there is a corresponding reduction in the number of connections and of units requiring attention. With the storage batteries there will be eight connections in all, whereas with the primary cells there will be 32 exterior connections and a great many more internal connections which are often liable to bad contact. The chances of failure due to broken or bad connections are therefore very much reduced by the use of the storage cells. Within the past year there have been but very few failures due to the storage batteries, and these cases were generally due to broken jars or carelessness in placing a discharged cell in service. With the old primary cell system, fully half the signal failures were due to the primary cells.

Another point of great advantage for the storage cell is the difference in available capacity. It may happen that one semaphore, for some reason or other, is worked a great number of times within a short period. In a case like this, the signal, after a number of movements, will work very slowly, or possibly not at all. This is of course due to the polarization of the primary cells which effect is not perceptible in the storage cell. In consequence, with the storage cell operation is always sure.

PHILADELPHIA & READING RY.—Some months ago this road completed the work of substituting storage batteries for the primary cells operating the signaling devices between Wayne Junction and Huntingdon St., Philadelphia. This is a particularly congested section of road, and the concentration of the various devices requiring current has made the comparison of cost to furnish power by primary cells and by storage cells greatly in favor of the latter. It is estimated that the cost of the storage battery installation will be returned within the first year's operation.

The original installation of storage batteries consists of 268 cells, having 24 ampere hours capacity, distributed at eight points between Wayne Junction and Huntingdon St., a distance of approximately 12,500 ft. There were previously 1,203 primary cells distributed at these same points.

In determining the capacity of the storage battery required for each of these stations, it was assumed that with the exception of the disk signals the various devices would consume the current continuously and that it was desired to provide for a period of 24 hours' service from the batteries without recharging. Since the above assumption as to continuous service is far on the safe side, the capacity of the batteries thus determined should have considerable margin of reserve. While in general practice it is customary to design cells to have more than 24 hours' reserve capacity, the conditions in this case were such as to make it unnecessary. The distance between stations is very small and the district covered most accessible. In the event of trouble, therefore, it would not be difficult to rectify this in a very short space of time.

The ampere hour output from the different stations varies considerably, and voltages for various circuits vary from 6 volts to 40 volts. It was desired to adopt a uniform size of cell, in order that one charging rate would suffice for all cells. The standard cell adopted, therefore, was one having a capacity of 24 ampere hours. At those stations where the ampere hour output is greater than this amount, two or more sets of these cells were placed in parallel. This forms a very flexible method of operating, since each battery can be increased at any time in the future, if necessary, by the addition of an extra set placed in parallel with the others. In order to provide for those cases where two or more different voltages are required from the same station, a sufficient number of these cells were installed in series to give the maximum voltage required. Resistance in the form of Counter E. M. F. cells was then installed in sufficient amount to obtain the minimum voltage required. By taking taps from this series of Counter E. M. F. cells, circuits of any voltage between the minimum and the maximum can be obtained. The storage batteries in each station were installed in duplicate. The leads from each battery were brought to a slate switching panel on which was mounted an arrangement of knife switches.

In order to charge the batteries, a small direct connected generator was placed at Nicetown, this machine having a capacity of 275 volts and 10 amperes. A duplicate machine was also installed to serve in case of breakdown. From this generator two circuits of copper wire

*Abstract of a paper presented at the New York meeting of the Railway Signal Association on Jan. 10.

were run, one north toward Wayne Junction and the other south toward Huntingdon St. The North circuit takes in stations No. 1, 2, 3 and 4 in which 66 cells are charging; and the South circuit includes stations 5, 6, 7 and 8 in which 68 cells are charging. It is thus seen that the charging is done in two circuits instead of one. It was necessary to do this in order to keep the voltage of the charging below 275. In order to equalize any slight differences in the resistances of the two lines and also to compensate for the cutting out of batteries on one circuit independently of the other, a rheostat was installed at the power house capable of being inserted in either circuit, this box having a resistance of 45 ohms and a carrying capacity of 5 amperes. Each day one of the batteries in each station is charged while the other battery is operated upon the signal circuits. The batteries on charge at the various stations on each charging circuit are in series with each other and are cut out one by one as they are filled.

The change from primary batteries to storage batteries was made without interruption of service of any of the signaling devices, and there was not a single failure reported while the work was in progress.

The costs of the two systems are estimated as follows: Batteries, battery panels, engines and generators, switchboard, wiring, $2,300. As a return upon this investment it was figured that $2,100 annually would be saved in cost of maintaining the old primary batteries. From this should be deducted the maintenance charge on the present installation. This was taken at 10%, or $230 annually. Deducting this from the gross saving, we have a net saving of $1,870. The storage battery installation was credited with 75% each for the old 1,203 primary cells displaced. This amounts to $902 and reduces, therefore, the net investment on the present apparatus to approximately $1,400. It will thus be seen that the estimated saving produced by the battery amounts annually to approximately 135% of the initial investment.

ILLINOIS CENTRAL RY.—Mr. Dunham, Signal Engineer, has given some interesting facts relative to the use of portable storage batteries in the operation of their block system. Between Fulton and Central City, an approximate distance of 100 miles, they have 23 operating stations. The line is a single track and a double arm semaphore is used, one for each direction. The semaphores are normally at danger, and are worked mechanically by the operator, but only at such times as he can get current from the battery situated at the adjacent signaling station. In this case the battery is not used to operate the semaphore, but provides current for signaling between stations and for unlocking the semaphores. It takes 1-10 of an ampere, for half a minute at the outside, to operate the magnet circuit; and as each battery works two semaphores, and there are 25 trains each way every day, this would mean 0.83 ampere hours per day, or 26 ampere hours per month. This is very liberal, as the time required to throw the semaphore after the battery is closed is nearer ¼ minute than ½. The portable batteries which are used have 33 ampere hours' capacity. Ten of these cells are used at each station, and charged once each month. Since the above estimate of ampere hours required for service is most liberal, it will be seen that the cells have a considerable reserve capacity.

PENNSYLVANIA R. R.—This company is operating storage batteries for signal work on the Philadelphia Division, extending westward from Philadelphia to Downingtown; on the Pittsburg Division, from Gallitzin to Wilmere; on the Monongahela Division, from Pittsburg to Thompson; on the Maryland Division of the Philadelphia, Baltimore & Washington R. R., from Philadelphia to Wilmington, and from Allegheny to Homewood on the Eastern Division of the P., Ft. W. & C. R. R.

In the first cases there are four tracks throughout, and in the last case there are four tracks from Allegheny to Rochester, and two tracks from Rochester to Homewood. In this distance (35 miles) there are 188 block signals and 8 mechanical interlockings. The blocks are from ½ to ¾ mile long. Batteries, consisting of four cells, having a capacity of 80 ampere hours, are installed at five or six points, in steel wells. Each well has two batteries, one charging while the other is discharging. The charging is accomplished by throwing the cells in series in a manner somewhat similar to that above-described in the Philadelphia & Reading Ry. system.

The first installation near Philadelphia was on the division between Philadelphia and Paoli, about three years ago. The signals between these points are spaced approximately 3,000 ft. and, in the base of each semaphore are placed two to four cells, capacity 80 ampere hours. One cell is discharged upon the track and signal circuits, while the other cells are being charged. The distance between Broad St., Philadelphia and Paoli is approximately twenty miles. Situated at St. David's, which is about the center of the division, are two 500-volt, 5-KW. generators. Two circuits of No. 6 copper wire proceed from this point, one to each end of the road. These are the charging circuits, one generator being used upon each. Switches are installed in each signal base, and each day an inspector goes over the route and changes the batteries from charge to discharge. While the batteries are thus inspected each day and charged every second day, the cells are of sufficient size to operate the signals for five or six days. It is thus seen that they have a very large margin for reserve.

With the old system of gravity cells it would be necessary to install about 24 primaries in the place of each of the two storage cells. The gravity system would require five or six times the number of men for handling the batteries. With the old system of gravity cells it was customary to have two distinct batteries, one upon the track circuit and one upon the signal circuit. With the storage battery scheme one cell operates both.

The maintenance of storage cells is to a certain extent dependent upon the care which they receive, and it is therefore of great importance that the operating men thoroughly understand the best method of inspecting and operating the cells.

With the cells used in permanent locations and charged over a transmission wire, the following suggestions are made for inspection and operation: At each battery location, as stated above, there will be duplicate sets, one being used on the discharge while the other is being charged. One representative cell should be selected from each of these sets at each battery location. This cell in each case will be termed the pilot cell. The level of the solution in this cell should be kept at a fixed height, ½ to ¾-in. above the tops of the plates, by the addition of small quantities of water, as necessary. This pilot cell should be used for frequent readings, described below. From this cell the condition of the other cells in the same series is judged. The above, of course, applies to conditions where there are several cells in series on each set. In those cases where there is but a single cell used for operation, as is very often the case in the base of semaphores, the readings should be of course taken upon that cell.

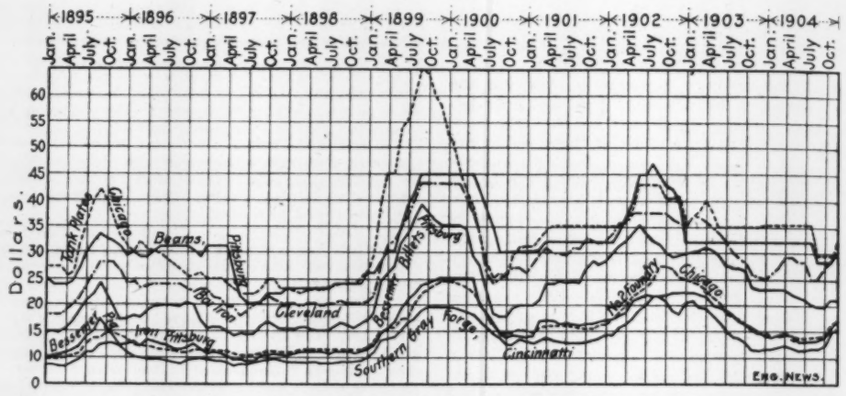
CHARGING.—In this class of work it is of the utmost importance to have a considerable reserve capacity in the battery, and in order to best accomplish this the battery should be charged at very frequent intervals, dependent upon the conditions operative upon each road. For example, upon the system of the Pennsylvania R. R. between Broad St. and Downingtown, although the cells have a sufficient capacity to operate the signals continuously from five to eight days, it is customary to charge each day. Conditions upon other roads might make it preferable to change this to every other day, etc.

Since it is impossible to adjust the amount of work upon each battery so that all sets are equally discharged, it will naturally arise that some of the sets will require a longer time for recharging than others. Where it is possible to do so, the cells which first come up to charge should be cut out, and thus prevent their overcharging. Where this is not practicable, the entire series of cells on charge should be cut out from the charging circuit when that set of cells which has done the greatest amount of work has been charged, and care should be used to prevent prolonging the charge beyond this point. During these frequent charges it is advisable not to charge the cells up to their maximum, but to cut off the charging current when the density of the solution has risen to within about three points of the maximum. Once a week, if the cells are charged every day, this charging current should be prolonged for about ½ to ¾ hour after all of the cells have reached their maximum specific gravity. The effort should be made throughout all of this work to charge the minimum necessary amount, with the exception of the weekly overcharge, as stated above. It should be further explained that during the charge the specific gravity of each cell gradually rises until it has reached the maximum point, when the battery is filled. After this point there is no further increase in the specific gravity. Corresponding with this maximum point in density, the maximum voltage of each cell is reached, and thus forms a further check upon the proper time for cutting the cell out of the charging circuit.

DISCHARGING.—Storage cells designed for the use of signal work should always have a very considerable reserve capacity, consequently in most cases it is inadvisable to entirely discharge the cell in service. Since this is the case in this class of work, it is not necessary to keep any special watch of the specific gravity on the discharge, provided it is known as a positive fact that the cell is not being used to the extent of its entire capacity. The fall in specific gravity during discharge below the maximum point should not be greater than 15 or 20 points in ordinary operation.

FLUCTUATIONS IN IRON AND STEEL PRICES, 1894 TO 1904.

The accompanying chart, reproduced from "The Iron and Trade Review," shows the fluctuations in the prices of steel and pig iron during the last decade. The prices given are in dollars per short ton for finished steel, and per long ton for pig iron and steel billets. The price curves are plotted from average prices during each month and do not represent fluctuations within the month. The table from which the price curves of 1904 were plotted is given herewith:



FLUCTUATIONS IN IRON AND STEEL PRICES, 1894 TO 1904.

AVERAGE MONTHLY PRICES OF IRON AND STEEL PRODUCTS IN 1904

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
No. 2 Fdy Chicago	$14.10	13.75	13.55	14.00	13.80	13.40	13.30	13.35	13.40	13.70	15.00	16.00
Gray Forge Cincinnati	$11.00	11.00	11.25	11.75	11.25	10.75	10.75	11.00	11.00	11.75	14.25	15.00
Tank Plates Chicago	$35.30	35.30	35.30	35.30	35.30	35.30	35.30	35.30	29.30	29.50	29.30	30.10
Billets Pittsburg	$23.00	23.00	23.00	23.00	22.00	21.50	21.00	20.00	19.50	19.50	21.00	21.00
Bessem'r Pig Pittsburg	$13.00	13.35	13.85	14.10	13.60	12.60	12.50	12.65	12.75	13.35	15.25	16.00
Beams Pittsburg	$32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	28.00	28.00	28.00	30.00
Bar Iron, Cleveland	$25.00	26.00	27.00	29.00	29.00	28.00	28.00	25.00	25.00	27.00	28.00	32.00

A CENSUS OF THE AMOUNT AND COST OF WAGON ROAD TRAFFIC IN IOWA.

At the last meeting of the State Legislature the Iowa State College at Ames was made the State Highway Commission of Iowa. Funds for carrying the new law into effect became available July 1, 1904. This work was assigned to Dean A. Marston of the Division of Engineering and Dean C. F. Curtiss of the Division of Agriculture. Mr. T. H. MacDonald was engaged to take immediate charge.

Since July 1 the commission has, by personal investigation, studied the methods of good roads construction in various eastern states in which state aid laws are in force. Further, a general study has been made of the road question in Iowa and a considerable amount of data collected which will soon be published in bulletin form. Construction has been begun of road maps of each county, classifying the roads as regards travel, and indicating the improved roads.

An important feature of the work undertaken is the collection of detailed data in different parts of the state regarding the exact amount of travel over the country roads and the cost of the same. Records are also being kept of the prices of farm produce in different parts of the state, together with records of the conditions of the roads. In the matter of collecting the data regarding the amount and cost of travel, the commission

has just succeeded in having included in the questions to be answered in the taking of the state census in the spring of 1905 the agricultural road schedule. When the cards are returned by the census officers more complete information will have been secured on the subject of travel over country roads of this state than has ever been attempted to be collected by any state or government. The list of questions is as follows:

AGRICULTURAL ROAD SCHEDULE.

County .....
Town or Township .....
Name .....
P. O. Address .....
No. acres in farm.....
In what section located.....
Average distance to market.....miles.
No. hauled to market per year,..... Corn, ...
Oats, ...Wheat, ...Barley, ...other grains, ...grass and other seeds, ...potatoes and other vegetables, ... fruits of all kinds.
No. tons hay and other forage, ...
No. loads fuel to market, ...No. lbs. live stock.....
No. loads other produce.....
No. lbs. milk or cream delivered to creamery per day ..... for ..... days each year.
Distance to creamery.....miles.
No. loads fuel, building material, etc., hauled from market per year.....
Average size of full loads hauled.....pounds
Average time required for round trip, when hauling full loads .....hrs.
No. trips to market per week without considerable load.....
Average distance traveled per week on highways other than to market.....miles.
Deposits of road material on farm:

Gravel,	Yes.	Limestone,	Yes.
	No.		No.

Remarks .....
Signed .....
Assessor.

RELIEF WORK DURING THE TYPHOID EPIDEMIC AT BUTLER, PA.

The citizens of Butler, Pa., were fortunate in having the services of a man trained in the handling of money, supplies and employees during the epidemic of typhoid fever which occurred in that city about a year ago (see Eng. News, Dec. 24, 1903). That man was Mr. Richard H. Brodhead,* of the well-known Brodhead Contracting Co. The Butler Relief Association was organized at a mass meeting of citizens held on Nov. 29, 1903. Mr. Brodhead was living in Butler at the time. On the following day he volunteered his services and was immediately chosen as secretary of the association. The work which thus came under his charge rapidly grew in magnitude and was organized and carried out in the same business-like way as would have been applied to a contract. Mr. Brodhead has kindly loaned us a copy of the report made by him to the Butler Relief Association in April, 1904. The following statements have been taken from the report and are here put on record as of wide general interest and as of possible service in the case of future epidemics.

The organization of the association included executive, finance, ministerial, ward and auxiliary ladies' ward committees, besides committees on supplies, on cases needing relief and on coal, water and domestic needs. The maximum number of employees in the service of the association, including nurses, was 115. Besides the Butler County General Hospital, four special ones were used for typhoid patients and a nurses' home was provided. The special hospitals were provided through private benefactors. Supply rooms and a diet kitchen were established.

Daily meetings were held by the executive committee for a considerable period, after which meetings were held every two days until Feb. 1.

All requests for nurses, money, provisions, medicines or supplies were reported by the chairmen of the ward committees and acted upon by the case committee and finally granted or refused (generally the former) by the relief committee. Applications for relief were made on blank forms which when filled in gave the following data: Ward or number, name of applicant, street number, and number of children and adults in family; number, names and ages of those sick, and date when sickness commenced; how many in family employed, by whom and amount of weekly income; needs of family. Another form used was somewhat simpler, but gave the name of the attending physician.

Where the relief granted took the form of payment of rent a statement from the owner was required, certifying his ownership of the house, its location, occupant, length of occupancy, monthly rental, amount of rent due and unpaid, character of sickness in family and probable income of tenant. The same blank contained space for the endorsement of the action of the committee on the case and a form of receipt for rent paid by the association.

A clerical force kept order and supply books for each ward, giving full particulars as to amount of order and on whom issued, as well as particulars as to the family involved, the latter including names of doctor and nurse. Various ledgers were also kept. All bills against the association were first submitted to the secretary for examination as to items and additions and previous approval by department heads. If satisfied as to these points the secretary issued a treasurer's voucher, but this was not honored and a check issued until the clerical force had verified the bill by the ledgers in which relief orders were entered.

Large quantities of spring water and also a large water sterilizer were contributed from outside the city. The sterilizer was used after the spring water had been exhausted. The water was distributed to houses and the returned bottles were sterilized by steaming at least 15 minutes before they were filled and again sent out. The laundry committee did a large amount of work, made necessary by the disorganization of families through sickness and the difficulties of securing domestic help. Laundry collections were made, on proper notification, from all houses where typhoid fever existed, provided the clothing had been properly disinfected. Domestic help was supplied in some instances, but this seems to have been one of the most difficult tasks undertaken by the association.

*Now of Port Jervis, N. Y.

THE PRESIDENTS OF FOUR GREAT AMERICAN ENGINEERING SOCIETIES.

(With inset sheet of portraits.)

According to our annual custom, we present this week the portraits of the Presidents of the four great national engineering societies, with accompanying biographies.

As our readers will recall, one year ago, we included four other of the national societies in our list and presented the portraits of eight Society Presidents. This year, however, the Presidents of the Naval Architects, the Railway Engineering and the Testing Materials Societies have all been reelected; we return, therefore, this year to our previous custom and include only the four great representative national engineering societies which cover the four grand divisions of engineering work in this country.

In the preparation of the biographies, however, we have this year made a notable departure. Instead of collecting the data and preparing the biography through our own staff, we have been successful in securing for each of the Presidents a biographer who is himself a distinguished engineer, and who through intimate personal acquaintance with the man of whom he writes and with his professional career, is well qualified to record his notable achievements. The biographies which follow, therefore, are of more than ordinary interest.

Charles Conrad Schneider: President American Society of Civil Engineers.

By James Christie, M. Am. Soc. C. E.

C. C. Schneider was born at Apolda, in the Duchy of Saxony, Germany, in the year 1843. At an early age he entered a machine shop, where he served an apprenticeship as a preliminary to his engineering education. In 1864 he graduated from the Royal School of Technology, at Chemnitz. After his graduation he spent a few years in his native land and came to this country in 1867. His first employment in his adopted land was at Paterson, N. J., where he served for about three years as draftsman and designer at the Rogers locomotive works.

Mr. Schneider was quick to perceive the large field for development that lay in the branch of the profession that he subsequently adopted, and chose it as the principal study of his life. His name will be prominently associated with those members of the profession who have done so much during the past thirty years to study the science and perfect the art of structural engineering.

His first work in this line was with the Michigan Bridge & Construction Co., of Detroit, where he remained about three years. In 1873 he came to New York City, to take the position of Engineer-in-Charge of the Engineer's office of the Erie Railroad Co., under Mr. O. Chanute, Chief Engineer. While in the service of the Erie one of his duties consisted in checking strain sheets and plans submitted by bridge companies. At that time this was not a general practice. Railroads generally depended upon the bridge companies for the correctness of their designs. Another duty consisted in instructing inspectors. At that time experienced inspectors could not be obtained, as work was generally accepted without inspection. For this reason young men employed in the office, who showed some practical ability, were selected for that purpose and taken to some of the shops where work was in progress and given practical demonstrations in inspecting bridge work.

The year 1873 may therefore be considered as the period at which systematic bridge inspection was commenced. The bridges which were contracted for in 1873 were let on the competitive lump sum basis, which was then the usual practice. This, however, did not prove very satisfactory, as each bridge company at that time had its own type of truss, and it was concluded that the only way to obtain a reasonable uniformity in all bridges was to have the plans prepared by the engineers of the railroad company, and Mr. Schneider was charged with that duty. In 1874 the bridges which were needed during that year were designed by the railroad company's engineers and the work let on a pound price basis. This was probably the first instance where bridge work was let by the pound on designs furnished by the railroad.

In 1876 he was engaged with the Board of Engineers appointed by the Long Island Bridge Co. to pass upon competitive plans for a railroad and highway bridge across the East River, to connect Long Island with New York City. It was the intention to locate this bridge between 76th and 77th Sts., the location being selected as the narrowest point in the East River, requiring spans of only 734 ft. across the west channel and 618 ft. across the east channel. The project, however, was not carried out at the time, on account of financial embarrassment of the company. After this work was finished he was engaged by the Delaware Bridge Co. as a designer until the latter part of 1877.

In 1877 Mr. Schneider opened an office as Consulting Engineer in New York City, and for several years was engaged in connection with various important enterprises of that period. In 1879-1883 he was associated with the late George S. Morison, on the Plattsmouth, Bismark, Blair and Rulo bridges across the Missouri River and the Snake River Bridge at Ainsworth, Washington. In the years 1882-1883 he designed the cantilever bridge over the Fraser River for the Canadian Pacific Ry., and the Niagara River cantilever for the Michigan Central R. R.

These two bridges stand amongst the first of the modern type of cantilever. Mr. Schneider's name will always be associated with the development of this type of structure. Many other important works were of his design, notably the extensive wooden viaduct at Marent Gulch on the Northern Pacific and the Stony Creek viaduct on the Canadian Pacific R. R. He also designed the anchorage for the Statue of Liberty in New York Harbor. In 1886 he was awarded the first prize for the design of a bridge over the Harlem River at New York, intended for the site of the present Washington arch bridge.

In 1886, the A. & P. Roberts Co., of the Pencoyd Iron Works, Philadelphia, added a bridge and construction department to their iron manufacturing plant and Mr. Schneider became associated with these works in that year, as Chief

Engineer. These works developed very rapidly and within twelve years from their origin, had a productive capacity of 8,000 tons per month. This largely exceeded the output of any bridge shops elsewhere. In 1893 the Long Island R. R. Co. took an interest in the project of a bridge over the East River at Blackwell's Island, previously referred to, with a view of establishing a terminal in New York City. Work was actually commenced and competitive designs for the bridge were invited in 1894. The bridge was to accommodate four railroad tracks, with approaches and a terminal station west of Second Ave., New York City. The plans adopted by the Long Island & New York Bridge Co. were the designs of Mr. Schneider and submitted by the Pencoyd Iron Works, of Philadelphia, to which company the contract for the entire steel superstructure of the bridge and approaches was awarded in March, 1895. Considerable work had been done on this bridge on piers and foundations and complete detail drawings of the superstructure made and a portion of the material rolled, when, on account of the death of Austin Corbin, President of the Long Island Railroad, the company again became disorganized and the project was abandoned.

It would require a long list to enumerate the important structures that passed through Mr. Schneider's hands at the Pencoyd Works, as they include some of the most important bridges and buildings in the country. In 1900, when the American Bridge Co. was formed, Mr. Schneider was elected Vice-President, in charge of Structural Engineering, which position he held until last year, when, desiring to be relieved of some of the burden, he was retained by the company as Consulting Engineer, devoting a portion of his time to private practice.

Mr. Schneider has been a frequent contributor to the proceedings of Engineering Societies and to the Technical Journals. He received the Rowland prize in 1886 from the American Society of Civil Engineers for his paper on the Niagara Cantilever Bridge. This, together with his "Standard Specifications for Railway and Highway Bridges," and his volume of "Standard Details" for the American Bridge Co. form a part of his contributions to technical literature.

Mr. Schneider is a member of the American Society of Civil Engineers, the American Railway Engineering and Maintenance of Way Association, the American Society for Testing Materials, the Verein Deutscher Ingenieure in Germany and the Engineers' Club of New York. He has served four years as a director of the American Society of Civil Engineers and two years as one of its Vice-Presidents.

John R. Freeman: President American Society of Mechanical Engineers.

By F. P. Stearns,* M. Am. Soc. C. E.

The election of Mr. John R. Freeman to the presidency of the American Society of Mechanical Engineers at its annual meeting in December, 1904, furnishes another evidence of appreciation of the breadth of his experience and acquirements. His early professional experience was mainly that of a civil engineer in its more restricted sense, subsequently, his business ability placed him at the head of important insurance corporations, and now he receives recognition of his standing as a mechanical engineer by being selected as president of the national society.

He was born on July 27, 1855, in West Bridgeton, Maine, and is a lineal descendant of Samuel Freeman, who came over with Gov. Winthrop's party and settled at Watertown, Mass., in 1630. His early days were spent on the farm and his education was begun in the district school of that place. A friend, writing of his younger days, says: "Mr. Freeman in boyhood had none of the advantages and helps that come from inherited wealth or powerful patronage; he inherited from his ancestry that most valuable of all transmitted riches, an untainted New England physical constitution that toughens and strengthens under the strain of hard work, and especially from a model mother came a clearness of perception and a spirit of loyalty."

*Chief Engineer, Metropolitan Water and Sewerage Board, Boston, Mass.

He continued his education in the public schools at Portland, Maine, and Lawrence, Massachusetts, where he made the most of his opportunities. From his early days he was exceptionally fond of mechanical matters and mathematical and scientific subjects interested him. While attending the Lawrence High School he took all of these subjects covered in a three-year course during his first two years.

His tastes and habits led him to adopt the profession of engineering, and he had the rare good fortune, during his vacations at the high school, to serve in the office of the Essex Company, of which company the late Charles S. Storrow, one of the earliest and most able of the hydraulic engineers in America, was the Treasurer and executive head. Here Mr. Freeman served directly under Hiram F. Mills, Chief Engineer of the Essex Company, eminent as a hydraulic engineer, and from his active connection with the work of the Massachusetts State Board of Health, a pioneer and expert in filtration and sanitary matters.

Mr. Freeman next took the full course in Civil Engineering at the Massachusetts Institute of Technology, where he easily mastered his engineering studies, and was graduated in 1876. After his graduation he again entered the office of the Essex Company and soon rose to the position of Principal Assistant Engineer.

At that time Mr. Mills was conducting experiments which rank among the most important ever made in this country upon the flow of water, capillarity, friction, etc., although so little has been published regarding them that they are not generally known. That the scientific spirit with which these investigations were conducted and the infinite pains taken to secure rigidly accurate results impressed themselves upon Mr. Freeman, is evident when one examines his professional papers and reports. There is no doubt that the somewhat severe training which he received while in the office of the Essex Company under Mr. Mills has been an important factor in his subsequent success.

Mr. Mills acted as Consulting Engineer to various manufacturing companies in Lawrence and other parts of New England, and the details of much of this work fell to Mr. Freeman. One of the most important matters with which he was connected during this time was the development of the water power at Sewall's Falls, N. H., where under Mr. Mills he made a very complete investigation.

After his ten years' experience in Lawrence he decided to open an office in Boston for general practice in hydraulic engineering and mill work, but before he had an opportunity to do so he received an offer of a position as Inspector and Hydraulic Engineer for the Factory Mutual Fire Insurance Companies of Boston. He accepted this position for a year only, with the view that the wide acquaintance with mill men and mill architecture which it would promote would be of more value than the experience in strictly engineering lines. After he had occupied the position for a short time he appreciated what could be done in fire protection engineering with a well organized force, and was called upon to reorganize the inspection service, of which he was placed in charge, with the title of Chief Inspector and Chief Engineer.

His experiments on the hydraulics of fire streams are among the standard investigations of engineering and are well known. They are characteristic of Mr. Freeman's engineering work in that he not only made a complete investigation of the hydraulics of fire streams, but he demonstrated by his experiments that a nozzle could be made an extremely accurate water meter, and determined laws relating to the flow of water around curves in pipes which were of greater value than any experiments ever before made upon the subject.

Mr. Freeman has particularly sought to perfect standard methods and appliances for fire protection. The specifications almost universally adopted for underwriter fire pumps, underwriter nozzles, fire hose and the like were drawn up by him after much experimental work.

While occupying the position with the Factory Insurance Companies he was the active member of the Water Board of the town of Winchester, Massachusetts, the suburb of Boston, where he resided, and in July, 1895, he was appointed by the Governor of Massachusetts one of the original members of the Metropolitan Water Board, charged with building extensive new water supply works for Boston and the surrounding towns, receiving this appointment on account of his standing as an engineer and his executive ability.

An incident in connection with the beginning of this work is characteristic of Mr. Freeman's methods and energy. At an early meeting of the Board, one forenoon, it was decided to use a large unoccupied house for administrative and engineering offices, removing partitions and changing the arrangement of the rooms. These changes were placed in charge of Mr. Freeman, who engaged the reconstructing force the same afternoon, was in the building with the man in charge before seven o'clock the next morning, and when a motion was made at a meeting of the Board later in the forenoon to reconsider the vote of the previous day, with a view to a somewhat different plan, he remarked that "the motion to reconsider is not in order because the partitions are down."

He remained upon this Board until a change of residence made it necessary for him to resign, and had much to do with the successful organization of its great work and with the conduct of its affairs.

During the latter part of his stay in Boston he was, on two occasions, appointed by the Supreme Court to be one of three commissioners to appraise the value of water works, and in addition, he acted as consulting engineer to a number of manufacturing corporations on matters of construction and water power development.

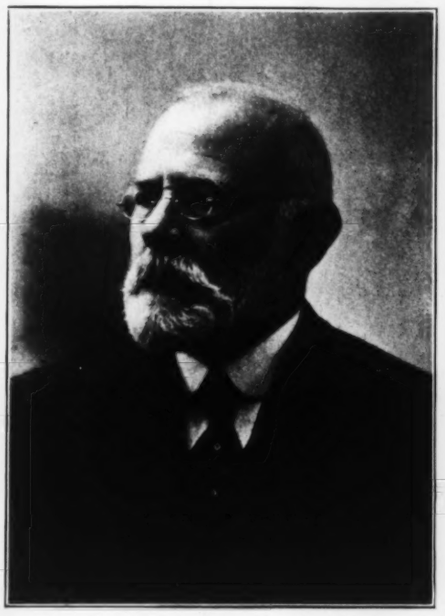
Early in 1896 Mr. Freeman became President and Treasurer of the Manufacturers, Rhode Island and Mechanics Mutual Fire Insurance Companies of Providence, R. I., the two first-named being the oldest of the "New England Factory Mutuals" companies organized by certain extensive manufacturers to insure large factory property exclusively and to safeguard it against fire by scientific precautions. Under his charge their business has increased threefold. His success was such that a year ago, on the death of Col. Thomas J. Borden, Mr. Freeman was called upon to become President and Treasurer of three more companies of the same character, known as the State, Enterprise and American. At the present time he is accordingly in charge of the fire protection and insurance interests of property valued at about $350,000,000, making his office the largest of its kind.

It would be reasonable to infer that interests of such magnitude would fully occupy the attention of any man, but Mr. Freeman's engineering instincts and physical endowments have not permitted him to be satisfied with such eminent success, and he has steadfastly declined to be wholly diverted from engineering work. He has been almost constantly engaged upon very important engineering work, and has been fortunate enough to be able to select chiefly those cases where there was opportunity for original scientific investigation.

His most important achievement is the investigation and report upon the New York Water Supply, after his appointment as a "wholly disinterested engineer" by Comptroller Coler, who was at that time making a strong fight against the proposed contract with the Ramapo Water Company. The instructions were "to get together as much reliable information on New York's need for more water as is possible in the time available and present it without reserve." On March 23, 1900, seven months after his appointment, Mr. Freeman presented a report which is one of the wonders of the engineering world. As printed, it is a volume of about 600 large pages, profusely illustrated with maps, diagrams and designs, and the work involved in preparing it can only be appreciated by one who has read it.

There are in it not only the usual features of a report upon the water supply of a large city, but a very full and original treatment of the problem of water waste and an unusually complete study of the capacity and adequacy of existing sources.

In this study Mr. Freeman found it desirable,

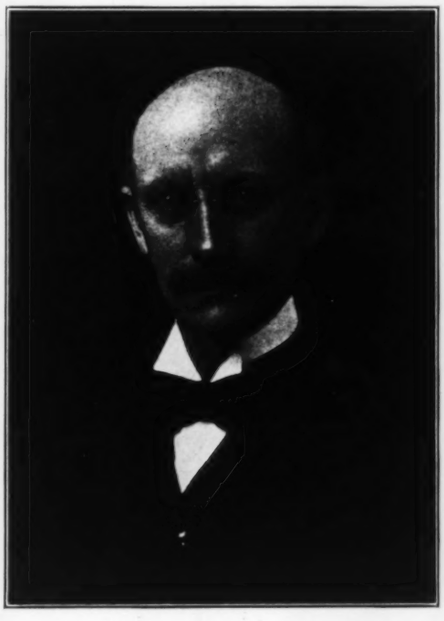


C. C. Schneider

President of the American Society of Civil Engineers.

John R. Freeman

President of the American Society of Mechanical Engineers.



James Gayley

President of the American Institute of Mining Engineers.

President of the American Institute of Electrical Engineers.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

on account of the unreliability of the records, to do such work as to recompute from the original notes of semi-daily measurements the flow of water over the Croton Dam for 32 years. He also determined the hydraulic formulas applicable to this dam by special experiments at the Hydraulic Laboratory at Cornell University.

Even with the knowledge that during the last three months on this work Mr. Freeman's day commonly began at four in the morning and ended at eleven at night, it is difficult to comprehend how he could have done this in addition to his very important regular duties. It certainly could not have been done except by a trained and active brain combined with a vigorous body.

Fully as important as the New York report as a contribution to engineering and scientific knowledge, is the report made by Mr. Freeman in 1903, as Chief Engineer of a committee appointed in 1901 to consider the advisability of constructing a dam across the Charles River between the cities of Boston and Cambridge for forming a large water park. The project had been before the public for many years and had been strongly opposed by powerful private interests so that it was necessary to furnish conclusive evidence as to the effect of the dam upon the many sanitary, hydraulic, navigation and other features involved. The investigations as conducted showed an appreciation by Mr. Freeman of the advantages to be attained by the cooperation of experts in different lines of applied science. In the many appendices there are valuable contributions by the pathologist, chemist, biologist and geologist, and by engineers who are specialists in sanitary and harbor engineering, all prepared by men whose opinions have great weight. The execution of the recommended works has been authorized and a contract has been made for the building of the dam.

In December, 1902, Mr. Freeman was appointed with Messrs. Wm. H. Burr and Rudolph Hering, a Commission on an Additional Water Supply for the City of New York, and the well-known comprehensive and valuable report of this Commission, which makes a printed volume of about 1,000 pages, was made in November, 1903. Recently this Commission has been revived to make a further report upon the same subject.

The latest extended report made by Mr. Freeman is that submitted after more than a year's investigation, to the Massachusetts Metropolitan Park Commission on the tidal regulation of the Mystic estuary and the sanitation of the marshes in its vicinity.

Only the most important of other works upon which Mr. Freeman has been engaged can be mentioned. He made an elaborate series of experiments on the flow of water through pipes at Nashua, N. H., the results of which have not yet been published. He has acted as consulting engineer on the Nashua, N. H., and Asheville, N. C., water works, and on the great water power installation at Massena, N. Y.

After his resignation from the Massachusetts Metropolitan Water Board, he continued to act as its adviser in the settlement of mill damages amounting in all to more than two million dollars, and he was connected with suits in both Massachusetts and Rhode Island growing out of the condemnation by the city of Worcester of the headwaters of the Blackstone River, which have especial interest on account of the interstate rights involved.

Mr. Freeman was Vice-President of the American Society of Mechanical Engineers in 1903 and 1904. He was a director of the American Society of Civil Engineers from 1896 to 1898, and Vice-President in 1902 and 1903, and was also President of the Boston Society of Civil Engineers in 1893.

At the present time Mr. Freeman is a director of the National Bank of Commerce, the Rhode Island Hospital Trust Company, and of the People's Savings Bank of Providence, and a trustee of Butler Hospital. He is also a member of the corporation of the Massachusetts Institute of Technology, and a trustee of the Rhode Island School of Design.

Mr. Freeman has an attractive home in Providence, R. I., which he enjoys with his wife and six sons. He has a very wide circle of acquaintances, particularly in engineering and manufacturing lines, and many steadfast friends, including, especially, his present and former associates and subordinates. He has a keen sense of humor and enjoys a joke even when at his own expense.

James Gayley: President American Institute of Mining Engineers.

By John Birkinbine,* Past President, M. Am. Inst. M. E.

From the position of chemist in charge of a modest laboratory at a blast furnace plant to the senior vice-presidency of the largest corporation in the world is a step of marvelous advance. This summarizes the career of Mr. James Gayley. When it is considered that this step, or the series of steps represented, covered less than twenty-five years, the story becomes the more remarkable.

This advance may be credited by some to good fortune. And it *is* fortunate to win the confidence and esteem of employers, resulting in progressive responsibilities; but such winning is not gratuitous, it is the sequence of personal application and of demonstrated merit. Any progress may be considered due to favoritism, but favors in business are not usually bestowed upon those who fail in faithfulness, or who are neglectful of duties assigned to them. There are times in one's life when advantage taken of existing conditions result in advance which otherwise would be won by some one else, and here discretion in recognizing the opportunity is a factor.

To be championed by a man reputed as keen and discerning as Mr. Andrew Carnegie, and who commands such great wealth, is of itself an asset; but those best acquainted with Mr. Carnegie know that championship would not be given to, and has not been bestowed upon, any who failed to serve him well. Therefore the steps by which a comparatively young man reached a position of so much importance attract interest and may be worthy of emulation. That it is generally believed that merit is the basis for the advance noted, is evidenced by the selection of Mr. James Gayley by his fellow members as President of the American Institute of Mining Engineers. It was peculiarly appropriate that his incumbency of the office coincided with the American visit of the Iron and Steel Institute, with his former employer, Mr. Andrew Carnegie, as President of that organization.

James Gayley was born in Lock Haven, Pa., in 1855. As son of a Presbyterian minister he had no preparatory advantage in the study of iron metallurgy in his youth. Any resulting deficiency, however, was fully made up by subsequent studies; he received an excellent education, which was completed by a course at Lafayette College in 1876. It is interesting to note that as an appreciation of the value of technical education, and to permit his Alma Mater to better equip its students in chemistry, Mr. Gayley lately presented to Lafayette College a fine laboratory building thoroughly equipped.

Immediately after graduation, with the degree of Mining Engineer, Mr. Gayley entered the service of the Crane Iron Works, at Catasauqua, Pa., as chemist, receiving a salary of $500 per annum. In 1880 he became chemist for the Missouri Furnace Company, subsequently assuming charge of the blast furnace plant at South St. Louis, and after remaining in Missouri for three years Mr. Gayley returned East to become furnace superintendent for the E. & G. Brooke Iron Company, at Birdsboro, Pa. In 1885, while serving in this capacity, the late Capt. W. R. Jones called Mr. Gayley to the Edgar Thomson Steel Plant, near Pittsburg, Pa., where he passed through various positions, having in charge the blast furnaces and finally the entire plant.

While managing the blast furnaces of the Edgar Thomson Steel Works, Mr. Gayley assumed prominence in the generous rivalry for pre-eminence in blast furnace practice, which was then pronounced, and is still officially encouraged between the Illinois Steel Company and other large plants, and the Carnegie plants. Fuel being an expensive item in the production of pig iron, at Chicago, the practice there was to run with small blast volume, while at Pittsburg where fuel was cheap the reverse was the case. To Mr. Gayley is due much of the credit for the practice which secured large furnace output and low fuel consumption with moderate volumes of blast. It is no reflection upon other progressive blast furnace managers to assert that Mr. Gayley's results at the Edgar Thomson plant, fifteen years ago, were phenomenal considering the available mechanical appliances, the output based upon the cubical capacity of furnaces, and the tonnage made from a furnace without relining, in combination with low fuel consumption.

Recognizing possible economies in handling material to and from the blast furnaces, Mr. Gayley advocated numerous labor-saving devices, and is responsible for the introduction of many such appliances at blast furnaces and on ore docks. He also is credited with making the initial installation of compound blowing engines at American blast furnaces.

Mr. Gayley's inventions have attracted attention and contributed in advancing the iron and steel industry. Among these a bronze cooling plate for blast furnace walls is widely used. Another, an auxiliary casting stand for Bessemer steel plants, to hold the steel ladle while the heat is being poured, relieves the crane, thus permitting two converters to make the output formerly produced by four.

Recognizing Mr. Gayley's practical knowledge of metallurgy, Mr. H. M. Curry had him assigned to the Pittsburg office as an associate, and he succeeded Mr. Curry in the function of supplying the enormous plants of the Carnegie Steel Company with their raw materials. This brought him in close contact with mining methods, transportation facilities, coking appliances, etc., and he directed the mining, purchasing, shipping, sampling and distribution of more iron ore and assembled a bulk of ore, fuel and flux, at his company's furnaces probably greater than any one person had done before.

While Mr. Gayley was in charge of the Edgar Thomson plant, it was the writer's privilege to be in frequent correspondence with him in relation to a feature of blast furnace economy which he has lately developed, and which is attracting widespread interest. This correspondence was triangular in so far as it affected Mr. Gayley, Mr. Edgar S. Cook, President of the Warwick Iron Company, and the writer. Hygrometric equipments were established at the Edgar Thomson plant, and at the Warwick Iron Company plant at Pottstown, Pa., and from the foundation thus laid, after many years of persistent labor, there has been developed a practical installation, now in operation at the Isabella Furnace at Pittsburg, for extracting the moisture from air which is driven into blast furnaces.* What this invention may mean for the iron industry may be presented in a brief resume of results so far demonstrated.

In blast furnaces producing iron with ores from the Lake Superior district, the raw material, amounting to about 7,200 lbs. per ton of iron, varies in composition only within 10%, and is as uniform as human skill can make it; but the atmosphere, of which 11,000 to 12,000 lbs. are required per ton of iron, varies in its content of moisture from 20 to 100% from day to day and often in the same day, thus rendering the process, even with the best appliances, an uncertain one and dependent on the caprice of the atmosphere. The chilling effect produced in the furnace hearth caused by a leaking tuyere immediately results in a deterioration in the grade of the iron, and yet the quantity of water ordinarily entering the furnace under these conditions is not much in excess of the quantity carried in by the atmosphere, during a period of the average humid conditions prevailing in the summer season in this country.

With air containing one grain of water per cubic foot, there is passed into the blast furnace, for each 1,000 cu. ft. used per minute, practically one gallon of water per hour. Furnaces of average size in the Pittsburg, Pa., district, receive

*Odd Fellows' Temple, Broad and Cherry Sts., Philadelphia, Pa.

*See Engineering News of November 3, 1904, page 390.

about 40,000 cu. ft. of air per minute, which would pass into the furnace 40 gallons of water per hour for each grain of moisture contained in a cubic foot of air.

The apparatus constructed to overcome the defects resulting from moisture in the air has been in successful operation for several months, and the results reported suggest that the application of dry air to blast furnaces and converters may revolutionize much of the present practice. As the dry blast was supplied to the Isabella furnace it became necessary to reduce the speed of the blowing engines, and furnish about 8% less blast, since the air supplied to the engines was lower in moisture than the natural atmosphere and contained more oxygen per cubic foot, and the tendency of the furnace was to drive too fast. The saving in coke consumption, 20%, reduces the phosphorus in the metal, and this, in making Bessemer iron, permits the use of higher phosphorus ores. It also extends the term of usefulness of important fields producing coking coal. If the hearth temperature was suddenly lowered, principally from accretions on the bosh reaching the hearth, the sulphur did not increase when using the dry blast, and in this respect the furnace has shown a remarkable uniformity in composition of the metal produced.

The increase in uniformity in the working of the furnace, which is obtained through the dry blast, would result in a decrease in the blast pressure, and it would appear in any event that the saving in power consumption in the blowing-engine room would nearly or quite compensate for the requirements at the dry-blast plant. In addition to the economies effected, the furnace can be operated with precision; it works with greater regularity, and in consequence the product is uniform with respect to grade and composition, which makes the dry blast of particular value in the making of foundry iron, which is marketed by grade. The increase in output, 20 to 25%, reduces the capital invested in plant per ton of iron produced, and affects similarly all fixed charges about a blast furnace plant.

While the application of the dry-blast to the blast furnace has effected economics and produced a more uniform metal, its adaptation to the Bessemer converter is expected to result in great benefit, since air is used in large quantities, and the varying humidity affects the temperature of the charge, and in consequence the quality of the steel.

The story of Mr. Gayley's business life would necessarily embrace a record of the close application to detail and exact measurement demanded in the chemical laboratory; of constant attention and anxiety required of blast furnace managers; and of the strenuosity which characterizes all departments of a large plant producing steel rails. It would form a picture of a broad grasp of the location and character of the deposits of iron ore, coal and limestone; their mining and quarrying; the conversion of coal into coke; and the shipment and handling of millions of tons of raw material which enter into the production of pig iron; also the conversion of iron into steel, its fabrication in rails, bars, plate shapes and varied products, and an acquaintance with the demand for these throughout the world.

John William Lieb, Jr.: President American Institute of Electrical Engineers.

By Calvin Winsor Rice,* M. Am. Inst. E. E.

The choice of President of a national engineering body is made with such care that the recipient of the honor may very properly regard it as the highest distinction which his associates in the profession can confer upon him. In honoring Mr. Lieb with its presidency, the American Institute of Electrical Engineers pays a tribute also to that portion of the profession which represents the engineering and management of the Central Station. It needs hardly to be mentioned that the central station which Mr. Lieb represents, the New York Edison Company, supplies the largest electric distribution system in the world, and one of the most successful; and, as success in an electrical enterprise is much more often dependent upon intelligent management than upon the electrical features of the system, a combination of executive with engineering ability indicates a rare type of successful man.

*348 Central Park West, New York, N. Y.

John William Lieb, Jr., was born in Newark, N. J., on February 12, 1860. He attended the Newark Academy, and in due course the Stevens High School at Hoboken. In 1880, at which time the late Dr. Robert H. Thurston was at the head of the Mechanical Engineering Department of the Stevens Institute of Technology, at Hoboken, N. J., Mr. Lieb graduated in that department.

Immediately after graduation he entered the employ of the Brush Electric Company, of Cleveland, O., as draftsman. The following year he took a similar position with the Edison Electric Light Company, at 65 Fifth Avenue, New York, N. Y. This was a separate company from the associated concern which did the manufacturing. After a short time Mr. Lieb was transferred to the latter, the Edison Machine Works, which had just been established at 104 Goerck St., New York, for the manufacture of generators.

Previous to this time, that is, before the years 1881-1882, all generators for incandescent lighting were belted, and were made in four sizes, known as "E" 15 Lights, "Z" 60 Lights, "L" 150 Lights, and "K" 250 Lights. In the demonstration which Mr. Edison made of his system at Menlo Park, N. J., lighting houses and streets, etc., in the fall of 1880, there were 10 belted generators employed, lighting 425 16-c. p. lamps. Mr. Edison at this time conceived the idea of a single direct-connected generator as a substitute for a number of smaller belted dynamos, and that same fall at his Menlo Park Works he built such a machine, designed to run at a speed of 600 r. p. m. In the spring of 1881, with the idea of improving materially on the first design, Mr. Edison commenced what was afterward known as the "Jumbo," a dynamo having a capacity of about 50 KW., or, for those days, about 500 16-c. p. lamps. This was the first successful direct-connected steam-driven generator, and was that same year sent to the Paris International Electrical Exposition. Mr. Lieb assisted in the testing of this first "Jumbo," and therefore was present at the very beginning of the commercial art of electric lighting.

History was making fast, and plans were at this time completed for an extensive plant at 255 Pearl Street, New York, for a central station for the Edison Electric Illuminating Company. The territory undertaken to be lighted covered about one square mile, included between Wall Street and Spruce, Ferry and Nassau, to the East River.

The original installation consisted of six Porter-Allen engines of about 125-HP. nominal at 120 lbs. steam pressure, and running at 350 r. p. m., direct-connected to Edison "Jumbos." Mr. Lieb was put in charge of the installation of the electrical equipment, under the direction of Mr. Charles L. Clarke, Chief Engineer. After assisting in the testing and experimenting incident to starting up this, the first commercial station in the United States supplying current for incandescent lighting and power from an underground system, and on the inauguration of regular service September 4, 1882, under the auspices of the Edison Electric Illuminating Company, of New York, Mr. Lieb was appointed its first electrician.

The exhibition at Paris as well as the plant in America attracted world-wide attention, and about this time a syndicate of Italian capitalists, with Prof. Colombo as technical adviser, was organized, and purchased a complete equipment of boilers, engines and dynamos for an Edison lighting station at Milan, the theater Santa Radegonda having been purchased as a site. Mr. Lieb was selected by Mr. Edison to direct this installation. It was begun about October, 1882, and on March 8, 1883, the first installation was complete and started in regular operation. By June of that year four "Jumbos" had been installed, by August the full equipment of six "Jumbos" was completed, and in November continuous service, night and day, was begun.

Mr. Lieb remained in charge of the organization of the Italian Edison Company, becoming in turn Chief Electrician, Director of Stations and Chief Engineer in general charge of the technical departments of the company, engaged in manufacturing electrical apparatus, installing isolated plants, and constructing and operating central lighting and power stations throughout I[taly]. Under his guidance the Milan Edison Com[pany] was among the very first to exploit the alter[nating] current system of distribution (beginni[ng] 1886), and one of the first in Europe to mak[e] tensive use of the Thomson-Houston system o[f] lighting. The last work in Italy with which Lieb was identified was in the electric rai[l]field, in connection with the installation o[f] trolley system for the city of Milan. In all Lieb completed a ten years' engagement in I[taly].

In 1894 he was offered an appointment wit[h] old company, the Edison Electric Illumin[ating] Company, of New York, which he accepted, became Assistant to the First Vice-Presi[dent] from which he advanced by steps to Third [Vice-] President, and finally to General Manager. [After] the consolidation of the various lighting inter[ests] in New York City under the corporate nam[e of] The New York Edison Company, Mr. Lieb was a[p]pointed Third Vice-President and Associate G[en]eral Manager, which position he now holds.

Soon after the successful starting of the fir[st] Edison central station there was formed an Ass[o]ciation of Edison Illuminating Companies, whi[ch] has since increased, so that now it comprises sev[en]ty-three companies in America and the Societa Generale of Italy. Mr. Lieb has taken a very active part in the work of this association, has served as its President two years, and is now a member of its Executive Committee and Chairman of its Committee on Incandescent Lamps.

Extending the usefulness of the Association there was formed the Electrical Testing Laboratories, which was the outcome of a desire to secure for a number of small companies the same benefits that testing laboratories give to departments of the Government, the Pennsylvania Railroad Company, etc., and to serve the public as do commercial concerns like the Pittsburg Testing Laboratories. The principal work of the Electrical Testing Laboratories is testing the quality of incandescent lamps purchased by the Association, but they are also equipped for the general work of electrical testing for the public. As President of the Electrical Testing Laboratories, Mr. Lieb has devoted a great deal of attention to this work, and may be properly given much of the credit for the high plane on which the investigations are made.

Mr. Lieb is a Director in several electrical corporations, besides those mentioned. He is also member of the council of the American Society of Mechanical Engineers, Past-President of the New York Electrical Society, member of the American Institute of Electrical Engineers, of the American Society of Civil Engineers, of the Associazione Elettrotecnica Italiana, of the Franklin Institute (Philadelphia), of the Engineers' Club of New York, of the Municipal Art Society, and of the American Museum of Natural History. He has been honored on several occasions by his fellow graduates of the Stevens Institute with appointments within their gift, such as President of the Alumni Association, Alumni Trustee, etc. He has now been elected President of the American Institute of Electrical Engineers.

During this last summer, the American Institute of Electrical Engineers received a return visit from the Institution of Electrical Engineers of Great Britain, and, at the same time, a visit was made by members of the Associazione Elettrotecnica of Italy, in all numbering about 100 people. Mr. Lieb acted as Chairman of the Committee of Arrangements for their entertainment, which included a three-weeks' tour through the principal cities of the United States. This tour was marked by such complete success, that, as a token of appreciation, and in recognition of services in connection with the pioneer work of electric lighting and traction installation in Italy, Mr. Lieb has been decorated by H. M. the King of Italy with the insignia of Knight Commander of the Order of the Crown of Italy.

Of the successful men of New York, very few are natives of the city or vicinity. Mr. Lieb's success is therefore the more noteworthy because he was born and educated in the immediate vicinity of that city, where he obtained his early professional training, and where he now occupies so prominent a place among New York's industrial engineers.

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The young art of building in reinforced concrete is marked by no more surprising or interesting phenomenon than the ready and wide acceptance given to the stress-strain law formulated by the French engineer Considère. This alleged law, according to which concrete will, in the presence of reinforcement, deform many times more than does unreinforced concrete, is a proposition of the kind easier to assert than to prove or disprove. Its author cited experiments he had made which in his opinion demonstrated the "law." But the essence of this law is so much in disagreement with fundamental principles—it asserts that the same material under the same conditions will behave differently in different surrroundings—that one would naturally require the most positive demonstration before accepting it. Yet, resting on Mr. Considère's statement alone, the law he announced was accepted as such by a very large number of intelligent and experienced men.

Two years ago Prof. F. E. Turneaure tested Considère's observations by careful check experiments, and was able to show that, at least in the Wisconsin atmosphere, the "law" did not hold, the concrete behaving in quite orthodox manner even when reinforced. He showed also that Mr. Considère's experimental evidence was to be considered as mere negative testimony at best, that is as a failure to find results which more thorough work might have disclosed.

Soon afterward Prof. A. N. Talbot obtained a series of experimental results on reinforced-concrete beams which pointed to the same conclusions reached by Prof. Turneaure. In the light of these destructive experiments Considère's "law" has lost most of its authority in America.

In Europe there has hitherto been no experimental study in this direction. The "law" was widely accepted there, and mathematical theories of reinforced beams were developed from it. As a matter of fact, the resulting design of a reinforced-concrete beam is not much affected by the use or rejection of Considère's law, since in most cases the total tension carried by the concrete is small compared with the tension in the steel, when the beam is designed with even moderate care. This explains, perhaps, why there has been so little effort to obtain experimental evidence in regard to the "law;" workers in reinforced concrete have been too busy designing and building structures to devote much time to experimental testing of a matter which is of minor importance in practice.

Recently, however, some careful experiments were made at the Stuttgart Technical College which bear on Considère's observation. They support the conclusion that the "law" is not justified by fact, and thus supply the first European evidence parallel to that brought out in this country by Professors Turneaure and Talbot.

The tests were made upon beams of 6½-ft. span and consisted mainly of careful measurements of the deformations on the tension side. Details of the experiments are not available at present, but are of secondary importance, in view of the earlier American work. It is more important to note the fact of these experiments, and the general conclusions which they yielded. Their author, Mr. A. Kleinlogel, concludes (1) that the rupture deformation of reinforced concrete is not materially greater than that of plain concrete, and (2) that with tensional reinforcement varying from 0.18 to 2.66%, there is a slight increase of ultimate elongation of the concrete as the percentage of reinforcement increases. The latter observation may, of course, be explained by the equalization of strong and weak spots in the concrete when a large percentage of reinforcement is present.

In a field which contains so many inherent difficulties and perplexities for the designer as does that of reinforced concrete, the difficulties of theory and of practical development would be much increased by the occurrence of anomalous action such as is expressed by Considère's principle. It is desirable, therefore, that if an alleged principle of anomalous behavior proves to be unfounded it should be overthrown and abandoned as speedily as possible. The above note of the German experiments, while it is merely a contributory item in support of what has already been established by the work of Turneaure and Talbot, is given here with the purpose of furthering this end.

Analytical chemistry is so commonly looked upon as an exact science that it will come as a surprise to many of our readers to hear that the analyses of cement and cement rock, copper slag, and zinc ore, differ widely according to the method used and the chemist using it. The Committee of Uniformity in Technical Analysis, appointed by the American Chemical Society, has recently issued in pamphlet form a report giving the itemized results of the analyses of zinc ores by 42 chemists experienced in such analysis. The extreme variations in results are so great as to be startling. The highest and lowest percentages found in three samples of zinc ore are as follows:

	—Sample A.—		—Sample B.—		—Sample C.—	
	Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
High..	59.73%	3.26%	39.22%	21.92%	38.86%	15.00%
Low...	56.03%	2.10%	12.20%	18.04%	28.90%	8.40%

Sample A was a zinc blende from Joplin, Mo.; Sample B, oxidized ore from New Jersey, containing franklinite, willemite, and zinc spinels; Sample C, impure blende from Colorado.

Not less startling than these results are others, published in this report, on copper slags and cements. The Committee says:

> The showing of the Tables I. to IV. is ample demonstration that analytical chemistry, as ordinarily practiced, is anything but an exact branch of the chemical profession. Mr. Waring has furnished additional data from his own experience, to which nearly every chemist could add, showing lack of agreement that is all too common, often leading to serious consequences, aside from the reflection cast upon the profession at large. . . . . There is a growing, and seemingly well grounded opinion, which has been given expression by Mr. Thorn Smith and the authors of the zinc report that our methods of teaching are largely accountable for the unsatisfactory state of affairs.

The Committee aims to bring about a greater uniformity in the results of chemical analyses by comparing results obtained by different methods, by distribution of standard samples for analysis, by investigating the purity of reagents, and by such other action as may be deemed expedient. The Committee numbers four: W. F. Hillebrand, Chairman; Clifford Richardson, Secretary; Dr. Chas. B. Dudley; and H. N. Stokes.

The Chief of the Bureau of Yards and Docks, of the U. S. Navy Department, in his last annual report notes that the work of the bureau is much hampered by the want of a sufficient number of civil engineers to perform the duties assigned to this bureau. In some of the yards the engineers are overworked and are unable to give that personal attention and direction necessary to secure the best results; and in other cases details to general charge of work are not made at all for the reason that there are no engineers available for assignment. By the Act of Congress of March 3, 1903, it was provided that 28 Civil Engineers and 12 Assistant Civil Engineers should constitute the Corps of Civil Engineers of the U. S. Navy, but not more than three of the Assistant Civil Engineers should be appointed in any one year. At the present time there are 28 Civil and 4 Assistant Civil Engineers in the Corps.

The difficulty seems to lie in finding the proper material for Assistant Civil Engineers. The 1904 competitive examination for two Assistants was entirely without results, as none of the few applicants passed satisfactorily; though, as more time has been given for the examination ordered for January, 1905, better results are hoped for. Chief of Bureau M. T. Endicott finds a partial reason for the lack of interest shown in the corps in the relative smallness of the pay and the slowness of promotion. He recommends, therefore, that the Civil Engineer receive the same pay and the same allowances for quarters now granted by law to the Naval Constructors and Assistant Naval Constructors. The only alternative, he adds, is to make such a revision of rank in the Corps of Civil Engineers as would result in compensation more adequate to the service exacted and rendered.

The Civil Engineers of the U. S. Navy in the last fiscal year were responsible for the expenditure of over seven and one-half million dollars, and that our readers may better understand the recommendation of the Chief of Bureau in their behalf, and in the interest of a remuneration nearer in accord with the responsibilities of their duties, we note the pay of the Corps of Naval Constructors as compared with the present pay of the Civil Engineers. For the first five years after date of commission Naval Constructors are paid $3,200 per year for duty at sea or on shore, and $2,200 on leave or waiting orders. The corresponding pay of the Civil Engineer is $2,400 and $1,500. For the second five years the pay of Naval Constructors is $3,400 and $2,400; while that of the Civil Engineer is $2,700 and $1,800; and the duty pay of the Constructors is fixed at $4,200 per year after 20 years' service, while there is no such provision in the case of the Civil Engineers. The Assistant Naval Constructor starts with $2,000 per year, and the Assistant Civil Engineer with $1,500, and while the Constructors are allowed $12 per month per room for quarters, the Engineers receive no such allowance at all.

It may be said that in the case of the Assistants in both corps the pay is sufficient for a young man entering upon an honorable career, with increasing pay and retirement pay ahead of him when he reaches the age of 62 years. But the service is exacting and the duties of both the Civil Engineers and the Naval Constructor require a high degree of professional training and ability for their proper performance. Similar services are now well paid for in civil life as a rule, and unless the government is ready to pay at least nearly the market price for its engineers it can not expect to retain in its service the best men—others will want them and take them. The Chief of the Bureau of Construction and Repairs in the Navy Department says that while the Government has made provision for the gradual increase of the Corps of Naval Constructors, the number actually available for duty is a matter of serious embarrassment to the Bureau. Naval Constructors are in demand in civil life, and officers are frequently tempted to resign from the Government's service by the pleasanter duty and better salaries offered elsewhere. If this is the case with the better paid Naval Constructors, what chance has the Government of retaining in its service the highly-experienced engineer at a lesser pay? That public works of the highest importance should be well designed and economically executed demands

the best professional talent, and to obtain this necessary talent the Government must offer every inducement compatible with a wise and business-like supervision of public affairs.

COMMENTS ON RECENT SPECIFICATIONS.

Disputes over the measurement of excavation are not uncommon, and in spite of great care in drawing specifications a clause will occasionally creep in and lead to disagreement between engineer and contractor. An engineer has recently sent us the following as an example:

All excavation will be paid for by the cubic yard measured in excavation, and no allowance will be made for backfilling, or removing waste or surplus material upon the completion of the work. In estimating excavation no allowance will be made for excavation carried more than three feet beyond the outside lines of the foundation as shown on the plans.

The contractor did not excavate the earth as far beyond the lines of the foundation as might be permitted under this clause, namely 3 ft. But he claims that he should be paid for yardage estimated out to the 3-ft. limit, just as if he had actually excavated that far. Doubtless the contractor has in mind sewer trenching clauses which often state that the trench will be estimated as being a certain width, regardless of whether the contractor excavates more or less in width. The clause above quoted is not for trench work, however, and it is claimed by the engineer that 3 ft. was specified merely as the maximum permissible excavation outside the foundation lines in order to give room for any possible cofferdam, sheeting or other timber work that might be found necessary upon actually opening up the ground. This seems to us the more reasonable interpretation of the clause, particularly in view of the fact that the work is to be paid for by "the cubic yard measured in excavation." Having stated the cause of dispute it is easy to see how the wording of the clause might be changed so as to prevent similar disputes.

In the interpretation of general clauses, engineers often follow the letter rather than the spirit of the clause, with disastrous consequences to their employers. The following is one of the clauses accountable for many unfair acts on the part of young engineers:

The contractor shall commence and prosecute work at such points, at such times and with such forces as the engineer may direct.

This is an innocent looking clause, and one that is usually a dead letter until trouble arises between engineer and contractor over some other question. Then it is that an engineer who wishes to show his authority, and has nursed that very human desire to "get even," will dig up the clause which appears to give him unlimited powers. His first act may be to refuse to set slope stakes for the heaviest and, therefore, most profitable cuts; but he will insist upon the completion of all the skimming work involving the most expense per cubic yard. Where there is much grubbing of roots involved it is not a difficult matter for the engineer to pick out shallow scraper work that will cause the contractor to lose money on every yard of earth handled. In like manner the smaller culverts may be staked out first and stakes refused on the large pieces of masonry, perhaps until freezing weather is about to set in. All this is done with perfect right the engineer may say, for, "Is it not so nominated in the bond?"

The contractor has one unit price, it is true, covering heavy and profitable work as well as light and unprofitable work of the same quality, but, reasons the engineer, he should not have taken the work at all unless equipped with funds sufficient to carry out the work under the worst possible conditions. This being so, let us require him to attack the heavier excavation in mid-winter when the frost is in the ground several feet, and let him put a big force at work to make up for lost time during the previous summer. Does not the contract say distinctly that he shall "prosecute the work with such forces as the engineer may direct"?

That such reasoning as this has been sometimes used, there is reason to believe. That such rulings as these have been made, we know. The case is neither hypothetical, nor is it, unfortunately, without precedents. Therefore it may be used as an example from which both engineers and contractors can draw a profitable lesson.

To begin with, a contractor of limited means is foolhardy to sign a contract containing such a clause, unless he personally knows the engineer in charge and has good reasons for believing that no change of engineering administration will occur during the prosecution of the work. Exceptions to this statement occur where the contractor can secure such high prices that under no condition is it possible for him to lose a great deal of money, or where the contract is taken as a chance in a lottery. We have repeatedly called attention to the risks that are run by the contractor who signs away his liberty to handle his own forces.

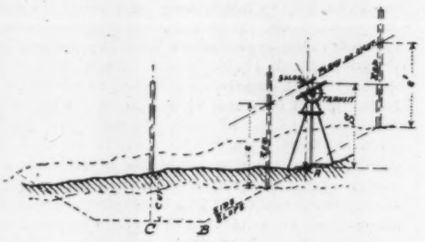

Fig. 1.

It may not happen once in a score of times that an engineer will overstep the bounds of reason or of justice, but that once may be sufficient to ruin a contractor financially.

We have assumed, up to this point, that the contractor has no redress, but to any one familiar with the law of contracts, it is well known that an unreasonable interpretation of such clause as the one under discussion will render the employers of the engineer liable for damages; for, carrying the clause to an extreme, it would be possible for the engineer to compel practical abandonment of the work during the summer months and the use of doubly large forces during the winter months—a procedure which would ruin almost any contractor. Yet this procedure would be literally in accord with the wording of the clause which empowers an engineer to designate the time and place of attack and the size of the working force. No court will uphold a contract under which one man, at his option, may ruin another. The extent to which an engineer may legally direct the forces of a contractor will depend upon the reasonableness of the engineer's rulings. To prove or disprove the reasonableness of any ruling is a matter of evidence as to the facts and of expert evidence as to common practice. The cost of a law suit and doubt as to the outcome have deterred many a contractor from bringing suit; but the fact remains that, whenever an engineer ceases to be fair and reasonable in his interpretation of such clauses as the one under discussion, he runs the risk of forcing his employers to defend a law suit which will be expensive to them no matter what the final decision may be.

LETTERS TO THE EDITOR.

Tables for Computing the Discharge from Flowing Artesian Wells.

Sir: Replying to an inquiry in Engineering News for Jan. 5, by Mr. F. L. Getman, Resident Engineer, Ithaca Water-Works, Ithaca, N. Y., for a formula for computing the discharge from flowing artesian wells by measuring the vertical height to which water rises above pipe, I would refer him to Water Supply and Irrigation Paper No. 67, of the U. S. Geological Survey, which contains tables for all diameters and various heights, such as he requires.

These tables are taken from a bulletin issued by Prof. J. E. Todd, State Geologist of South Dakota.

If Mr. Getman is unable to procure a copy of the above paper, I will be glad to furnish him with blue print of tables. Yours very truly, C. G. Hubbel.

Engineering Company of America,
Charlotte, N. C., Jan. 6, 1905.

Another Method of Setting Slope Stakes with the Aid of the Solar Attachment of a Transit.

Sir: In your issue of Nov. 17, 1904, Mr. Ralph E. Parker gives a handy method of setting slope stakes by use of a transit's solar attachment.

For heavy cuts, however, the method will not do, since a rod must be read at a height equal to the cut, [illegible] the depth below cut center of slope plane, plus inte[illegible]tion height of line of sight and rod at center stak[illegible] This would, in many cases, require the rodman to [illegible] a telegraph pole, which, with the necessity of usin[illegible]pell and note-book for calculation at each setting of th[illegible]ns-sit, constitutes a nuisance in cold weather.

The following method requires no calculation w[illegible]ver, the rod reading being a constant for every slope [illegible]ke or S. Figs. 1 and 2.

Clamp the solar's sight line perpendicular to i[illegible]lar axis. Find, by any of the well-known ways, a slop[illegible]nt A, and set up the transit so that when its solar [illegible] of sight is parallel to the plane of slope the point of [illegible]ter-section of solar sight line and solar polar axis is [illegible]tly over the slope stake A, as per illustrations.

Then, for both cut and fill, the rod reading, s, at a[illegible] slope

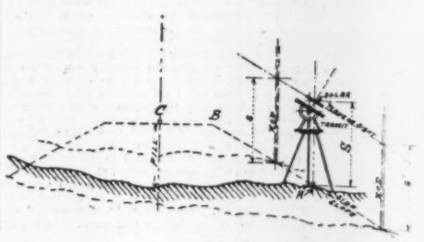

Fig. 2.

stake, will be the constant S, or height of said intersection point above the base slope point A. This does away with much pulling off of gloves and fussing with pencil and paper in windy wintry weather.

In running from cut to fill, or vice versa, the rod tends to cross the slope angle B, which is readily detected by the eye even in very rough ground, and the point definitely located by the tape. Yours truly,

Charles M. Jones.

303 Henry St., Brooklyn, N. Y., Dec. 31, 1904.

A Convenient Conversion Table from an Engineer's Note-Book.

Sir: I send herewith an excellent little conversion table which has had a place in my pocket note-book for many years, and has proven very useful. It is sent to you with the belief that it may be appreciated by other engineers. The arrangement of the table is especially commendable, as the entire conversion process is at once apparent, thus:

M (millimeters) × .03937 = I (inches), or, reversing,
I (inches) × 25.4 = M (millimeters).

Yours very truly, C. H. Nicolet.

La Salle, Ill., Jan. 2, 1905.

(The table sent, which we are sure many engineers will be glad to copy into their note-book, is printed below.—Ed.)

Millimetres	×	.03937	=	Inches.
"	=	25.400	×	"
Metres	×	3.2809	=	Feet.
"	=	.3048	×	"
Kilometres	×	.621377	=	Miles.
"	=	1.6093	×	"
Sq. Centimetres	×	.15500	=	Sq. inches.
"	=	6.4515	×	"
Sq. metres	×	10.76410	=	Sq. feet.
"	=	.09290	×	"
Sq. kilometres	×	247.1098	=	Acres.
"	=	.00405	×	"
Hectares	×	2.471	=	"
"	=	.4047	×	"
Cu. Centimetres	×	.061025	=	Cu. inches.
"	=	16.3866	×	"
Cu. Metres	×	35.3156	=	Cu. feet.
"	=	.02832	×	"
"	×	1.308	=	Cu. yards.
"	=	.765	×	"
Litres	×	61.023	=	Cu. inches.
"	=	.01639	×	"
"	×	.26418	=	U. S. gallons.
"	=	3.7854	×	"
Grams	×	15.4324	=	Grains.
"	=	.0648	×	"
"	×	.03527	=	Ounces, av'd'p.
"	=	28.3495	×	"
Kilograms	×	2.2046	=	Pounds.
"	=	.4536	×	"
Kilog. per sq. centimetre	×	14.2231	=	Lbs. per sq. in.
" "	=	.0703	×	"
Kilogram per cu. metre	×	.06243	=	Lbs. per cu. ft.
" "	=	16.01890	×	"
Metric tons (1,000 kilog's)	×	1.1023	=	Tons (2,000 lbs.)
"	=	.9072	×	"
Kilowatts	×	1.3405	=	Horse powers.
"	=	.746	×	"
Calories	×	3.9683	=	B. T. units.
"	=	.2520	×	"
Francs	×	.193	=	Dollars.
"	=	5.18	×	"

The Relations of Employers and Employees.

Sir: If possible, the writer would like to see a discussion in your columns of the following questions which, to the writer's knowledge, are being considered in reference to an actual case:

Who has the better claim to a temporary position made for the purpose of doing a definite piece of engineering work, which promises to consume a definite time: an

old employee who failed to obtain promotion to the position, but who had just claims for consideration, or a newly employed engineer who was given an unsolicited call to the position, to accept which he had to resign his other prospects? This second engineer came from a distance and knew nothing of any other claims.

Aside from any legal points involved, what is the just view of the following claims? Though an engineer was called to do a specified piece of work, the correspondence even stating the time that it would require, he retains his right to leave his employers at any time and his employers retain their right to dismiss him at any time they see proper, with or without giving any reason therefor. In the case of the employers mentioned, salaries of all employees are paid monthly.

What further responsibility has an engineer when his work is satisfactory to his immediate superior in the engineering department of his employers' business? The engineer acts under the direction of this superior, who keeps in close touch with the work, visiting it frequently.

A Reader.

New York, Jan. 11, 1905.

(Knowing nothing of the circumstances of the particular case other than the information above given, we should say that the engineer who came from a distance and gave up his other prospects to accept the offer is the man who is entitled to the position. We do not know what the "just claims for consideration" of the old employee may be; but the time to give those claims consideration was before engaging the new man and not afterward.

With reference to the second paragraph of the above letter: It is true that very many contracts for services, professional and otherwise, leave both parties free to terminate the contract at any time without notice. But honest and honorable business men are not accustomed to take advantage of extreme legal rights in such matters. The dismissal of any employee should be preceded by reasonable notice and conversely an employee who desires to leave is in honor bound to give also reasonable notice of his intention. The Golden Rule is a pretty good rule to apply to matters of this sort, and neither employer or employee will lose anything in the long run by following it.

As to the third question, we are in some doubt as to its purport. We should say that an engineer's responsibility is not limited to merely satisfying the man under whose direction he works. The full measure of his responsibility is to do the best work he is capable of doing and not merely enough and well enough to satisfy his superior officer.—Ed.)

More Concerning Business Men and Engineers.

Sir: I have followed, with much interest, the recent letters touching on the relations of "the engineer" to "the business man." "H. J. F.," in your issue of Jan. 5, has raised many interesting questions.

It would seem that the whole inquiry centers around what "the engineer" is, and what "the business man" is, on any given piece of work. If the engineer is a man versed in fine spun theories and given to astronomical exactness in field work, he will receive some hard raps from an unappreciative and unmathematical world.

If he is one of the "culture engineers" alluded to, in whom the esthetic and the sense of form and proportion have undue weight, he will find but little work in which his services are needed.

If he is well informed on the commercial side of his work and is able to patiently work out alternative plans and determine the most economical and efficient way of doing a piece of work, he will be appreciated by well informed business men, but set down as a fool by others. By such a self-assertive braggart, who prefers to be able to tell what work will cost and what is best at a glance will be considered a much more valuable engineer.

If the engineer's only qualification is "executive ability," or, in other words, ability to keep things moving in a rush, it matters little whether the best and most economical results are being accomplished or not, there are a number of business men who will consider him a success.

Now for the "business man." If he is strictly self made he will not be likely to need an engineer to tell him what to do. If fortune has brought him into the possession of a large sum of money (which his own efforts did not make) he is more than likely to rely on his money to supply lack of wisdom and to regard engineers as superfluous. Should he employ one, it is not to get the benefit of his knowledge and opinion, but merely some one to keep things in a ferment of activity, obeying his whim. What cares he for nice questions of economy!

If the business man is broad-minded and well informed he will feel the need of a broad-minded and well informed engineer, one who is in fact a "technical business man" in all that the expression implies. Since, then, the lack of appreciation so much complained of is due to:

(1) Ignorance on the part of the business man of the good to be accomplished by sound engineering, and

(2) A too frequent ignorance of the commercial side of the profession by engineers, it would seem that the hope for the future lies in *education*.

By this I mean the general diffusion of engineering knowledge among the masses, making them see what is to be accomplished by it, and also the study of the business connected with and benefited by his profession, by the engineer.

The technical schools all over the land are meeting the first requirement. The engineer must look to himself in the broad school of experience, to acquire the second requisite.

Possibly, in the millennium, the world will become sufficiently well informed to appreciate what is to be gained by correct technical work, and the engineer sufficiently informed in business methods to fully meet all expectations.

In the mean time, however, it behooves the engineer who has an eye to his own interests to study his employer as one of the natural conditions affecting an engineering problem, and to do as faithful and good work as the sense and temper of his employer will allow.

Very respectfully, J. N. Ambler.

Salem, Va., Jan. 11, 1905.

Calculating Irregular Cross-Sections.

Sir: Replying to Mr. Kauffman's query as to whether or not his system is used by others for calculating the area of cross-sections (Eng. News, Dec. 22), would state that the method is an application of the general formula

$$A = \tfrac{1}{2} \Sigma\, y_n (x_{n+1} - x_{n-1})$$

for finding the area of any polygon in terms of the rectangular coordinates of its corners. For instance, see Johnson's "Surveying," formula (3), page 210 (Edition 1900).

Respectfully, R. H. M.

Grand Rapids, Mich., Dec. 24, 1904.

Sir: In reply to Mr. Kauffmann's inquiry regarding the use of the system of cross-section calculation, as given in your issue of Dec. 22, I desire to say that I have seen the method given by him much used on irregular cross-sections. His problem would be stated as follows:

Distance.	Elevation.	Departure or Difference of Distances.	Added Elevations.	+ Double Areas.	− Double Areas.
0.0	42.3				
10.0	38.6	+ 10.0	80.9	809.00	
16.4	34.7	+ 6.4	73.3	469.12	
12.4	29.2	− 4.0	63.9		255.60
13.9	20.5	+ 1.5	49.7	74.55	
9.3	13.0	− 4.6	33.5		154.10
10.0	0.0	+ 0.7	13.0	9.10	
8.0	0.0	− 18.0	0.0		
22.3	57.2	− 14.3	57.2		817.96
10.0	50.4	+ 12.3	107.6	1,323.48	
0.0	42.3	+ 10.0	92.7	927.00	
		+ 40.9 = − 40.9		+ 3,612.25	− 1,227.66
				1,227.66	
				2)2,384.59 Double area	
				1,192.295 = Area.	

In the above statement I use a plus sign for westing and a minus sign for easting. A check on the signs is obtained by ascertaining if the sum of the plus quantities in the third column equals the sum of the negative quantities in the same column. Yours truly,

Walter Seely.

356 West 116th St., N. Y. City, Dec. 26, 1904.

A Method of Calculating the Area of Cross-Sections.

Sir: Replying to Mr. V. A. Kauffman's inquiry in Engineering News, Dec. 22, concerning "A Method of Calculating the Area of Cross-Sections," I have used this same scheme for a number of years, and can say I have never found any other method which is as satisfactory. However, I would like to supplement his demonstration with the following scheme of using it.

The section Mr. Kauffman uses would ordinarily appear in the following form:

(7)		(6)		(5)		(4)		(3)		(2)		(1)		(2′)		(3′)		(4′)
10.0	+	9.3	+	13.9	+	12.4	+	16.4	+	10.0	+	0.0	+	10.0	+	22.3	+	8.0
0.0,		13.0,		20.5,		29.2,		34.7,		38.6,		42.3,		50.4,		57.2,		0.0
		− 3.9		− 3.1		− 2.5		+ 2.4		+ 16.4		+ 20.0		+ 22.3		− 2.0		
		1170		20.5		1460		1388		1544		+ 846.00		1512		− 114.40		
		390		615		584		694		2316				1008				
		− 50.70		− 63.55		− 73.00		+ 83.28		386				1008				
										+ 633.04				+ 1123.92				

−	+
50.70	83.28
63.55	633.04
73.00	846.00
114.40	1123.92
301.65	2686.24
	301.65
	2)2384.59
	1192.295 Area.

Multiply each of the remaining cuts or fills by the algebraic difference of the distances out of the two adjacent readings, subtracting the one nearer the center from the outer.

One-half the algebraic sum of these quantities equals the area.

The following shows the solution in full:

0.0		13.0		20.5		29.2		34.7		38.6		42.3		50.4		57.2
10.0,	+	9.3,	+	13.9,	+	12.4,	+	16.4,	+	10.0,	+	0.0,	+	10.0,	+	22.3.

The width of the roadbed on the left being 10.0 ft, that on on the right being 8.0 ft.

The method of solution may be stated by the following brief rule:

Invert the cross-section and write at each end the respective width of roadbed over 0.0, at that side.

Multiply the center cut or fill by the sum of the distances out of the two adjacent readings.

This scheme of making the computations is rapid, and has the advantage of having them so they are easily checked and corrections can be made without having to recalculate the whole section.

This method will solve any area so long as the notes of that area have been based upon two perpendicular lines. I have found it specially useful in solving areas in railway work, where the line from which the distances out were measured, was not in the center of the section, viz., where the main track and the siding have been cross-sectioned at the same time, using the center line of the main track from which to measure the distances out.

Yours truly, John S. Worley.

The Riggs & Sherman Co., Toledo O., Dec. 24, 1904.

Notes and Queries.

A. S. K. asks for references to articles giving the details of bear-trap gates applicable to a waste-way 30-ft. long and 8 ft. high. While every one of the following references may not prove directly applicable, taken collectively they cover the subject of bear-trap design. In our issues of Oct. 18, 1890, p. 335, and Feb. 7, 1895, p. 84, will be found general discussions of bear-trap design and the development of American practice. In our issues of Aug. 9, 1894, p. 113, and Nov. 5, 1896, p. 298, references are given to text books and papers on bear-trap design. To these may be added Executive Document No. 78, House of Representatives, 42d Congress, 2d Session, which "contains about the fullest presentation of movable dams to be found in print." In our issues of Mar. 24 and May 26, 1898, will be found articles on the bear-trap gates on the Chicago Drainage Canal.

ANNUAL CONVENTION OF THE MICHIGAN ENGINEERING SOCIETY.

The 26th annual meeting of the Society was held at Lansing, Mich., on Jan. 11, 12 and 13. The proceedings comprised the reading of a series of twelve papers, and of committee reports on municipal works, roads and paving, land surveying, and the press. In addition to the above a short social session was held the evening of the 12th, at which Governor Warner was present. Mr. H. K. Vedder spoke briefly on the "Relation of the Engineer to Public Improvements," and Governor Warner in his response assured the Michigan engineers that they should have his hearty co-operation in any public improvements that would operate for the general welfare.

President Skeels, in his address, urged the members of the society to look farther in the future than they were wont to do, plan for ten years instead of five, twenty years instead of ten. To some of the older members, present-day engineering accomplishments surpassed the wildest dream of their youth, and those of the older engineers who had fallen behind in the race could attribute it largely to the fact that they had not realized how tremendous the scope of engineering development was to be, and, consequently, had not planned for the future sufficiently to bring success.

CONCRETE.—One of the largest pieces of steel-concrete construction in Michigan during the past year has been the Bridge Street Bridge,

of Grand Rapids (Eng. News. Dec. 1, 1904). It is a five-span bridge, with a total length only a few feet short of 500 ft., and a roadway width of 66 ft., carrying footpaths, wagon road and one street-car track. The concrete was laid in transverse sections of 15 ft., and Thatcher bars were used for reinforcement. The details of design and construction were presented in a paper by Mr. P. M. Lowverse.

A description of the new central heating and power plant at the Agricultural College of the University of Michigan was given by Prof. C. L. Weil. In addition to the power plant proper, which is to be equipped with five internally-fired Scotch marine boilers, of 150 H.P., there is a tunnel system 4,100 ft. in length, built of 1-2-4 broken stone concrete. Something over half of this tunnel was made 6 ft. wide and 6½ ft. high. Sides and bottoms were built straight, the top of the section being a semi-circular arch. The tunnel was built in 16-ft. lengths, and few cracks developed after the completion of the work. In all cases where cracks did appear, the section rested on firm clay. Considerable delay in the progress of the work was caused by quicksand, but not in a single instance did a crack appear when the section rested on quicksand. In preparing the foundation for the power house chimney, 12 ft. of quicksand were encountered, and 50 oak piles 18 ft. long were driven, upon which rested the concrete base, 21 ft. square. The piles were allowed to project up into the concrete a distance of about 1¼ ft., so as to give an added moment of resistance for wind pressure. The chimney is built of radial brick and is 125 ft. in height.

Mr. W. H. Goss described a concrete pump pit which was built at Bangor, Mich., in which the main feature was the method of preventing seepage through the side and bottom of the pit from a thin stratum of water-bearing sand. A sump-hole was dug, into which a half-barrel was fitted, a circular line of tile near the outside of the bottom leading the water to the sump. The pit was circular, and after the cylinder was finished to the top of the ground, the forms were reduced in diameter and a layer of 1 to 2 mortar 3 ins. thick was placed on the inside surface of the side, after which several coats of cement wash were applied. This stopped effectually the leaks in the side. Concrete was then placed in the bottom, and, lastly, the sump was filled with concrete.

MUNICIPAL.—The committee on engineering features of municipal work to be protected by ordinance brought in a report of a model street railway franchise, which, with the free discussion that followed, occupied the larger part of the last morning session. The two features of this franchise which called forth the most comment, were the provisions concerning the manner of the purchase of the property, should the city so desire, and the matter of free transportation. The first-named provision is to the effect that the city may purchase the property of the company which lies within its limits at any time during the life of the franchise, a judge of the Circuit Court being empowered to appoint an arbitration committee of three members to determine the value of the property, the company being allowed to rent the tracks in order to take care of its traffic which passes outside of the city limits, for an annual sum which shall not exceed 4% of the purchase price. Also, in case a franchise is granted to any corporation, that corporation may run its cars over the track of the first company, subject to the rules and regulations of that company in the conduct of its business, and the payment of a reasonable rental charge. The section regarding free transportation reads:

> Said company shall furnish free transportation over its lines within the city to police, firemen and all mail carriers when in uniform, and city officials when in discharge of their duties.

Other sections of the franchise provide that no train shall consist of more than two cars; concrete foundations under the rails are to be put in by the company upon proper notification by the city engineer, designs for such construction to be subject to his approval; the cost of new bridges which carry both roadway and street car tracks is to be borne jointly by the city and the company, the latter paying a proportion of the total cost in the ratio of eight feet to the total width of the bridge; rails inside the city limits and for a half mile outside are to be insulated from the rails beyond this half-mile limit, and all systems of returns proposed by the company shall be submitted to the Board of Public Works for their approval before being adopted or used. One criticism of the franchise was that as it takes on the nature of a contract, generalities should be avoided, and that definite specifications should be placed in the body of the franchise.

Prof. J. B. Davis, of the University of Michigan, in speaking on "Municipal Ownership," urged city officials to go slower in the granting of valuable franchises, and characterized the American system of appointing boards to look after its public affairs as a system of irresponsibility, and pointed to the European system, where there is more centralization of responsibility, as one which is greatly superior.

Mr. W. W. Brigden told of the changes in the water supply of Battle Creek. The former supply was from a small lake, and as summer cottages had sprung up on all sides of the lake the danger of contamination had increased, and the supply was changed to wells sunk into sandstone. The water of the new supply was much harder and contained a larger amount of iron, and a strong remonstrance came in from the laundries and manufacturing plants who used the water to supply their boilers, the suggestion being made that the old supply be used and a filtration plant put in.

SUCTION GAS PRODUCER.—The advantages of the suction gas producer over the pressure type was outlined in a paper by Mr. S. F. Seager. In this apparatus the fire is started by a small blower, which is shut off when the fire is well under way. The gas is then admitted to the engine, and the suction of the engine piston furnishes the draft through the fire, and keeps the fuel at the point of incandescence. The gas leaving the producer passes the condenser, the heat of the gas forming the steam. The whole is then led directly under the grate, and with the air drawn in forms the power gas. The gas then passes through the scrubber, where it is cooled and most of the dust taken out, from there through the sawdust cleaner, where all the remaining impurities are extracted. The engine using the gas is equipped with governor control on the admission of both air and gas. Anthracite is the best fuel for the apparatus, although coke and bituminous coal can be used with slightly less satisfactory results. The claim is made that a horse-power hour can be secured with 1 lb. of anthracite for small units and for the larger units this amount often drops as low as 0.8 lb. Only a few plants have been installed in this country thus far, but in Germany they are growing in favor each year.

COST FIGURING.—From a manufacturer's standpoint, C. E. Bement dealt with methods of figuring cost in piece-work shops. He said: "It is almost impossible to lay down any fixed rule for figuring costs. Of the two systems, the continuous and the individual, I believe the latter is better adapted to exclusive piece-work shops, and is the one employed by us in our establishment. Cost-keeping of this kind has several elements; first, cost of raw material; second, cost of labor put directly upon the raw material, or productive labor; third, unproductive labor; fourth, small items of shop cost, such as files, drills, emery wheels, etc.; fifth, superintendence and power, in which is included foremen and assistants, watchmen, engineers, firemen, repair-shop and stock-room men, teams and teamsters, light, fuel, etc.; sixth, business expenses which include bad debts, insurance and taxes, advertising, salesmen's salaries, office help, interest, rebates and allowances and numberless other small articles all of which must be taken into account. These give the cost of the article, and you have yet to add to this cost the 'sales per cent.' and 'profit per cent.' before you know how much you can afford to sell the article for in the open market." In addition to this he said that every superintendent must work out a system of cost-keeping peculiar to the needs of his own establishment, and while one may learn much from systems of cost-keeping which others use, yet a system should never be adopted bodily, but should in every detail be fitted to the particular case.

ROADS AND PAVEMENTS.—The committee reports that in twelve Michigan cities there is a total of 231,233 sq. yds. of bituminous pavement. Favorable reports are received from all of these with the exception of one pavement in Port Huron, which was laid on a spongy, undrained clay, and is now rapidly disintegrating. Another kind of road to receive some attention during the past few years in Michigan is cobble-stone macadam. Large areas of the state are covered with stone, which has come from the trap-rock district in the vicinity of Lake Superior, and Saginaw, Ludington, Midland and St. Clair all have well-built macadam streets, surfaced with this stone, giving a cheap construction, and being fully as satisfactory for residence streets as the more expensive pavements.

Invitations for the 1906 meeting of the society were received from Lansing, Jackson, Grand Rapids, Saginaw, Battle Creek and Port Huron. The following names were reported by the nominating committee to be later balloted upon by the members: President, H. K. Vedder, Agricultural College; Vice-President, A. C. Lane, Lansing, and F. Hodgman, Climax; Secretary-Treasurer, F. Hodgman, Lansing, and A. L. Holmes, Grand Rapids.

THE ABOLITION OF THE PANAMA CANAL COMmission was recommended by President Roosevelt in a special message transmitted to Congress on Jan. 13. We print the message in full, as follows:

I transmit herewith the report of the Isthmian Canal Commission, accompanied by a letter of the Secretary of War, under whose supervision I have by executive order placed the work of the commission. I concur with the Secretary of War in the view that the present provision of law, by which the work of building the canal has to be done only through a body of seven members, is inelastic and clumsy, and I earnestly recommend a change, so that the President, who is charged with the responsibility of building the canal, may exercise greater discretion in the organization of the personnel through whom he is to discharge this duty. Actual experience has convinced me that it will be impossible to obtain the best and most effective service under the limitations prescribed by law. The general plans for the work must be agreed upon with the aid of the best engineers of the country, who should act as an advisory or consulting body. The consulting engineers should not be put on the commission, which should be used only as an executive instrument for the executive and administrative work. The actual work of executing the general plans agreed upon by the commission, after receiving the conclusions of the advising engineers, must be done by an engineer in charge, and we now have an excellent engineer. It is, in my judgment, inadvisable, therefore, to restrict the Executive's choice of commissioners to representatives of the Engineer Corps of the army or the navy. The commission should consist of five, or preferably of three, members, whose respective duties, powers and salaries should be assigned to them by the President, and who should be placed under the member of the Cabinet whom the President desires. Of these men the one appointed as administrator of the canal strip should also serve as Minister to Panama.

AN ADDITIONAL WATER SUPPLY FOR NEW YORK City was reported on by the temporarily revived Burr-Hering-Freeman commission on Jan. 16. The report was addressed to Mayor McClellan, as Chairman of the Board of Estimate and Apportionment, and was in three sections, as follows:

(1) On the advisability of constructing more reservoirs in the Croton drainage area, as recommended by Mr. J. Waldo Smith, M. Am. Soc. C. E., Chief Engineer of the Aqueduct Commission, the report states that the immediate need of more water is imperative; that the installation of 100,000 meters in Manhattan and the Bronx would save more water than proposed reservoirs would make available, and that the meters could be set in less time and at less expense than would be required for the reservoirs; but that in the present state of official and public opinion no reliance can be placed on universal metering to meet the emergencies; and that as an insurance measure the expense required to construct the reservoirs would be warranted.

(2) As to suspending work on the easterly basin of the Jerome Park Reservoir and taking immediate steps to filter the Croton supply, the commission endorses Mr. Smith's recommendations to that effect and also the general features of the recent report on the same subject by Messrs. Hazen & Whipple (see Eng. News, Dec. 22, 1904). The commission is "decidedly opposed to the use of copper sulphate in the Croton supply" as a means of preventing algae growths, "because, remaining in the water, if carelessly introduced, it might endanger the health of consumers." It advises the immediate acquisition of land near Tarrytown for filters, as recommended in its report of 1903, and the covering of the two old Central Park reservoirs and the easterly basin of the Jerome Park reservoir to hold filtered water.

(3) The longest section of the report discusses the $91,000,000 plan for an additional water supply, wholly from the west side of the Hudson River, submitted recently by Mr. Geo. W. Birdsall, Acting Chief Engineer of the Department of Water Supply, Gas and Electricity. The Commission "finds itself unable to concur in the principal recommendations" of Mr. Birdsall's report because, among other things, of the "entire absence" of necessary "surveys and examinations"; because it prefers a cut and cover to a deep-level aqueduct, a more direct line and a larger aqueduct than Mr. Birdsall proposed; because it does not approve diverting water from upper Schoharie Creek into the Esopus Basin, and does approve of using Roundout Creek before drawing on Catskill Creek; and because it still believes that the new supply, as well as the Croton, should be filtered. The commission points out that the total length of deep-level aqueduct proposed by the Birdsall plan is 97 miles, as compared with the 29.85 miles of the existing New Croton Aqueduct; and that for 55 of the 97 miles no profile was submitted with the report, "nor does it appear that any surveys or examinations of any kind whatever" have been made for this long stretch of tunnel work.

LOCK AND DAM NO. 10, KENTUCKY RIVER, have been completed by the contractors, The Mason & Hoge Co., and the lock is now open to navigation. It is situated 176½ miles above the mouth of the Kentucky River and steamers can now go to College Hill, 23 miles farther. The lock is 148 ft. available length; 52 ft. available width; and has a lift of 17 ft. The lock and dam and approach walls have been all built of concrete. The entire work has been in charge of Lieut.-Col. E. H. Ruffner, Corps of Engineers. The contract for the work was closed June 30, 1902, and work was begun on Aug. 3. The contract date for completion was Aug. 13, 1905, and it will be seen that the entire work has been completed in less than 30 months.

OIL WILL BE PUMPED 2,000 MILES from wells in Indian Territory to the Standard Oil refineries in New York City. The route of the pipe line, which is said to be now ready for operation, is from Red Fork to Kansas City, to Whiting (near Chicago), to Cygnet, O., through Pennsylvania to Olean, N. Y., across New Jersey and under the Hudson and East Rivers to Greenpoint, N. Y.

AN AUTOMATIC TYPE-PRINTING TELEGRAPH system developed by Mr. J. C. Barclay, of the Western Union Telegraph Co., has been put into service between New York and Buffalo, N. Y. A paper on "High-Speed Printing Telegraph Systems" read by Mr. Barclay before the International Electrical Congress held at St. Louis on Sept. 12 to 17, 1904, referred to his work on the printing telegraph problem. The following is taken from this paper:

By substituting for the present recording arrangement (of the Buckingham printing telegraph system.—Ed.) a modified form of electrical typewriter of great sensibility and rapidity in action, a comparatively simple printing mechanism can be devised that will more fully meet the service requirements, and at the same time increase the legibility and improve the general appearance of the printed message. This is what the author has set out to accomplish, and his experiments so far demonstrate that a speed of at least 100 words per minute can be readily secured thereby. The particular changes necessary to bring this about involve the use of as many small printing magnets as are requisite for the desired number of mechanical operations. The printing magnets are actuated by local currents properly directed through the medium of certain electromagnetic selecting devices, whose particular function is to distribute the different signaling impulses among the various printing and auxiliary magnets in a manner appropriate to the requirements in the case.

WEST AUSTRALIA HAS PRODUCED about 400 tons of gold since mining for the precious metal was started there a score of years ago. During the last three years the output has been at the rate of about $40,000,000 per annum.

THE GOLD AND SILVER PRODUCTION in the United States for the year 1903 is given in the following table. The coining value of the silver is approximately 2.4 times the commercial value given in the table:

	Gold. Value.	Silver. Commercial value.	Total value.
Alabama	$4,400	.....	$4,400
Alaska	8,614,700	$77,544	8,692,244
Arizona	4,337,600	1,829,034	6,186,634
California	16,104,500	503,010	16,607,510
Colorado	22,540,100	7,014,708	29,554,808
Georgia	62,000	216	62,216
Idaho	1,570,400	3,513,906	5,084,396
Kansas	9,700	52,596	62,296
Maryland	500	.....	500
Michigan	.....	27,000	27,000
Montana	4,411,900	6,826,842	11,238,742
Nevada	3,388,000	2,727,270	6,115,270
New Mexico	244,600	97,578	342,178
North Carolina	70,500	5,940	76,440
Oregon	1,290,200	63,720	1,353,920
South Carolina	100,700	162	100,862
South Dakota	6,826,700	119,448	6,946,148
Tennessee	800	7,020	7,820
Texas	.....	245,376	245,376
Utah	3,697,400	6,046,272	9,743,672
Virginia	13,500	5,130	18,630
Washington	279,900	159,030	438,930
Wyoming	3,600	108	3,708
Total	$73,591,700	$29,322,000	$102,913,700

THE WEIGHT OF STEEL in various Pittsburg office buildings was given as follows in a paper by Mr. Edward Godfrey, recently read before the Engineers' Society of Western Pennsylvania:

Building.	Weight of steel per cu. ft. of contents of building.
Arrott Building	2.8 lbs.
Farmers' Bank Building*	2.3 "
Empire Building	2.1 "
Oliver Building	1.8 "

In the Phipps power building, described in Engineering News of Sept. 15, 1904, the structure is unusually heavy, to carry the weight of coal bin, water tanks, etc., and the total steel amounts to 3½ lbs. per cu. ft.

A RAILROAD ACROSS GUATEMALA will be completed within two years, it is said. Already 135 miles of the line are in operation, leaving a gap of only 65 miles to be built. This road is expected to be a competitor of the Panama Canal. It will reduce time of shipment from New Orleans to Guatemala City to five days.

NOTES FROM THE ENGINEERING SCHOOLS.

UNIVERSITY OF MICHIGAN.—The number of students now enrolled in engineering courses is 955, as compared with 777 last year. No other department has shown such an increase.

IOWA STATE COLLEGE.—By an act of the State Legislature the college has been made the State Highway Commission of Iowa, to carry into effect the new road law. Prof. A. Marston, Dean of Division of Engineering, will have supervision of this work. It is proposed to conduct a good roads school next June for the benefit of the road officers of the state. The college has secured road machinery and has already constructed a gravel road, using clay as a binder. Elsewhere in this issue the road census work of the College Commission is described.

POLYTECHNIC INSTITUTE OF BROOKLYN.—Courses of evening lectures are to be given at this institution as follows: Commercial Electrical Engineering (4 lectures), by Prof. Chas. F. Scott; Electrical Power Transmission (8 lectures), by Prof. Frederic A. C. Perrine; Central Station Practice (8 lectures), by Prof. William S. Barstow; Telephony, Telegraphy and Patent Practice (8 lectures), by Prof. Thomas D. Lockwood; Electric Traction (8 lectures), by Prof. Louis Duncan; Thermal Engineering and Ventilation (8 lectures), by William J. Baldwin; Mechanical Installations in Buildings (6 lectures), by Reginald P. Bolton; Mechanical Draft (2 lectures), by Walter B. Snow; Mechanical Preparation of Coal (2 lectures), by H. H. Stoek; Cold Storage and Refrigeration (4 lectures), by Gardner T. Voorhees.

Each of these lectures is two hours long, beginning at 7.30 p. m. The dates of the lectures and cost of each course may be had upon application to the Institute. The regular price is $7.50 for a course of 8 lectures, but admission is free to all undergraduates of the Polytechnic. Arrangements will be made to give evening instruction in laboratory tests, mathematics, or other subjects that are required for the degree of Electrical Engineer, provided there be a sufficient number of applicants to guarantee the expense. The lectures, it should be added, are in no sense "popular lectures," but are technical in character, and the work done therein will count upon the requirements for degrees of Electrical and Mechanical Engineer. In the fall of this year lecture courses will include: Operative Engineering, Steam Turbines, Gas Engines, High Speed Steam and Electrically Driven Machine Tools. Similar courses to the above are offered in Civil Engineering.

PERSONAL.

Mr. Joseph H. Young has been appointed City Engineer of Fulton, N. Y.

Mr. A. K. Crowell has been re-elected City Engineer of Taunton, Mass.

Mr. Winslow L. Webber has been re-elected City Engineer of Gloucester, Mass.

Mr. F. B. Locke has tendered his resignation as City Engineer of North Adams, Mass.

Mr. John N. Heeney has been reappointed Superintendent of Water-Works of White Plains, N. Y.

Mr. Preston H. Porcheron has been appointed City Engineer of Rome, N. Y., to succeed Mr. George C. Schillner.

Lieut. Charles T. Leeds, of the Engineer Corps, U. S. A., and Miss Amy L. Shapleigh were married at Newton, Mass., Jan. 12.

Mr. T. S. Moise, General Superintendent of Central of Georgia Ry., has been promoted to be General Manager, that position having been vacant since the death of Theodore D. Kleine last March.

Mr. Park Latimer, a civil engineer in the employ of the Amalgamated Gold Mines Co., and Miss Maud V. Brown were married recently at Flagstaff, Ariz. They will make their home at Quartzite, Ariz.

Mr. Eugene Klapp, M. Am. Soc. C. E., who for some time was a Division Engineer for the New York Rapid Transit Commission, has been appointed Consulting Engineer for the Brooklyn Rapid Transit Co.

Mr. Geo. E. Gifford, M. Am. Soc. C. E., for the past ten years representative of The King Bridge Co., of Cleveland, O., in New York, has resigned to accept the position of Contracting Engineer with Milliken Bros., 11 Broadway, New York.

Mr. George C. Whipple, M. Am. Soc. C. E., of the firm of Hazen & Whipple, Consulting Engineers, New York City, is to deliver a course of six lectures on Sanitary and Industrial Water Supply before the evening classes of the Polytechnic Institute of Brooklyn, N. Y.

Mr. F. H. Worthington, Engineer of Maintenance of Way of the Pennsylvania Lines at Fort Wayne, Ind., has been appointed Superintendent of the Peoria Division of the Vandalia, with headquarters at Terre Haute, Ind., to succeed Mr. F. T. Hatch, who has been appointed Chief Engineer.

S. L. F. Deyo, M. Am. Soc. C. E., Chief Engineer of the Interborough Subway Construction Co., was the guest of honor at a dinner given Jan. 10 by some 150 members of the engineering staff of that company, at Hahn's Restaurant, New York City. During the dinner Mr. Deyo was presented with a large silver punch bowl.

Mr. Wendell P. Brown, M. Am. Soc. C. E., for several years Engineer for The King Bridge Co. at their main office at Cleveland, O., has been transferred to the company's New York office at 277 Broadway, succeeding Mr. Geo. E. Gifford, whose resignation as Eastern Representative is mentioned above.

Mr. Geo. A. Howells, Manager of drill sales of the Rand Drill Co., was presented with a handsome loving cup by the officials of the company at a gathering of his associates and friends at the office of the company in New York City, Jan. 5. The occasion marked the 25th consecutive anniversary of Mr. Howells' connection with the company.

Mr. William P. Richards, for a number of years Assistant Engineer in charge of street extensions at Washington, D. C., has been appointed Surveyor of the District of Columbia, to succeed Mr. Henry B. Looker, whose death was mentioned in our last week's issue. Mr. E. M. Talcott, at present Assistant Surveyor, will succeed Mr. Richards.

Mr. Henry C. Mortimer, Jr., of the General Electric Inspection Co., has joined the New York office staff of the Crocker-Wheeler Company. He will assist F. B. De Gress, Manager of that office, and will succeed A. J. Thompson, who has accepted a position with the new York Branch of the Bullock Electric Manufacturing Company.

Mr. D. P. Beach, Assistant Engineer of the Pennsylvania Lines, Southwest System, at Cincinnati, O., has been appointed Engineer of Maintenance of Way of the Cincinnati & Muskingum Valley R. R., at Zanesville, O., to succeed Mr. F. M. Graham, who has been appointed to a similar position on the Pennsylvania Lines, Northwest System, at Fort Wayne, Ind., succeeding Mr. F. H. Worthington. Mr. W. L. Elkin succeeds Mr. Beach as Assistant Engineer at Cincinnati.

Mr. William H. Finley, M. Am. Soc. C. E., Principal Assistant Engineer of the Chicago & Northwestern Ry., has resigned to enter the contracting business as Vice-President and Manager of the Widell-Finley Co., with offices at Mankato, Minn., and the Monadnock Block, Chicago. He has been connected with the engineering department of the Chicago & Northwestern Ry. for 13 years, five years as Principal Assistant Engineer and for eight years previously as Engineer of Bridges.

Mr. W. W. Ewing, formerly Engineer of Tests of the New York City Building Department and since 1902 Chief Engineer of the Compania Generale de Asfaltos y Portland, of Barcelona, Spain, recently returned to the United States, having completed the cement works which he went to Spain to construct and which were described in Engineering News of May 5, 1904. Mr. Ewing has now become associated as Treasurer and Chief Engineer with the Thos. J. Brady Co., a corporation recently organized to undertake building and other contract work, with offices at 1123 Broadway, New York.

Mr. Corydon T. Purdy, M. Am. Soc. C. E., has been engaged by the Building Laws Revision Commission of the City of Baltimore to assist in the drafting of a new building code for that city. This Commission was created by the City Council to undertake the revision of the city's building laws. It is made up of Messrs. Edward T. Preston, Chairman; Benjamin T. Fendall, City Engineer; Fred. H. Wagner, Paul Turner, John Waters, Jos. E. Sperry, Wm. G. Nolting and Hon. E. Clay Timanus, Mayor, ex-officio. The members of the Commission are among the prominent business men of Baltimore. Insurance interests, architects and building contractors are all represented.

Mr. C. A. Alderman has been appointed Acting General Superintendent of the Dayton, Springfield & Urbana Electric Ry., the Urbana, Bellefontaine & Northern Ry., and the Springfield & Western Ry., with headquarters at Springfield, O. For the past eight years Mr. Alderman has been Chief Engineer for A. E. Appleyard, of Boston, Mass., in the construction of a large number of electric railway lines in the states of Wisconsin and Ohio. Mr. Alderman was interested in the construction of the roads of which he is now General Superintendent, and in addi-

*Engineering News, July-Dec., 1902, p. 217.

tion aided in building the Columbus, London & Springfield line, Columbus, Buckeye Lake & Newark line, Columbus, Newark & Zanesville line, Columbus, Grove City & Southwestern line, and the Central Market Street Ry. of Columbus, O.

Mr. Henry S. Manning has sold to Chas. A. Moore his entire interest in the firm of Manning, Maxwell & Moore, of 85 Liberty St., New York, together with his interest in the various manufacturing concerns, viz.: The Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hayden & Derby Mfg. Co. and Hancock Inspirator Co. There will be no change in the name or character of the firm of Manning, Maxwell & Moore and its business in the future will be conducted by Mr. Moore and the men who have been associated with him. The firm of H. S. Manning & Co. was started in 1873, and was succeeded by the firm of Manning, Maxwell & Moore in 1881. The growth of the business has been steady and constant and the firm now has branch offices in Chicago, Cleveland, St. Louis, Pittsburg, Boston and Philadelphia. Various manufacturing interests have been acquired so that to-day the concern is interested in the manufacturing industries of the Ashcroft Mfg. Co., manufacturing steam gages, indicators, pipe fittings, tools, etc.; the Consolidated Safety Valve Co., manufacturing safety valves; the Hayden & Derby Mfg. Co., manufacturing metropolitan injectors and ejectors; the Hancock Inspiration Co., manufacturing Hancock inspirators and valves of various kinds, and the Shaw Electric Crane Co., manufacturing electric traveling cranes. Mr. Manning's retirement from the firm was due to his desire to retire from business and to be relieved from business cares and problems.

Obituary.

Gates Curtis, an inventor and foundryman, died Jan. 13 at Ogdensburg, N. J., of paralysis. He was 82 years old.

Maurice F. Holahan, President of the Board of Public Improvements of New York City under Mayor Van Wyck, died Jan. 15 at the New York Hospital from cerebral hemorrhage.

Henry I. Budd, Commissioner of Roads of New Jersey, died Jan. 14 at his home at Mount Holly after an illness of a week. Mr. Budd had been Commissioner of Roads since 1895. He was 69 years old.

Edward Lindon Phillips, President of the Hewes & Phillips Co., engine manufacturers, of Newark, N. J., died suddenly Jan. 14 at his home in Chatham, N. J., from apoplexy. He was 54 years old.

George S. Lee, of Hawthorne, N. J., a mining engineer and Superintendent of the Ohioville Mine, died Jan. 13 in a hospital at Middletown, N. Y., as a result of a fall on the ice. Mr. Lee was 64 years old.

Robert Weir, for many years Consulting Engineer for the Union Subway Construction Co., of New York, died Jan. 17, at his home in Montclair, N. J. For a number of years Mr. Weir was connected with the construction department of the Croton Water-Works. He was 69 years old.

Benjamin F. Johnston, a member of the firm of Johnston Bros., railroad contractors, died at Saint Elmo, Ill., on Jan. 5, at the age of 55 years. Mr. Johnston built the Chicago; Paducah & Memphis R. R. and was President of that road until it was absorbed by the Chicago & Eastern Illinois.

George W. Kelsey, a railway contractor who built a number of military lines for the transportation of troops during the Civil War, died in Chicago on Jan. 9 at the age of 67. He and his father, as partners, are also said to have built the first street railways in New York and Philadelphia.

Joseph R. Sagee, Secretary, Treasurer and Assistant to the President of the Lehigh & New England R. R., died Jan. 14 at his home in Philadelphia, Pa., from heart disease. Mr. Sagee was 64 years old and had been connected with the Lehigh & New England R. R. since its organization.

Frank C. Johnston, an electrical engineer of Brooklyn, N. Y., died last week in San Francisco, Cal. Mr. Johnston had been employed in the Philippines in the construction of street railways, and finding that his lungs had been affected by the climate, was on his way to New Mexico, when taken ill at San Francisco.

Richard H. Terhune, M. Am. Inst. Min. Engrs., died at his home in Easton, Pa., Jan. 7, from paralysis of the heart. Mr. Terhune was a native of Hackensack, N. J., and had followed his profession as mining engineer at various places in this country, principally in the West. For some time he was a resident of Salt Lake City, Utah, and while there acquired considerable prominence in engineering circles in that vicinity. He was 57 years old.

Henry A. Cook, Superintendent of Water-Works of Salem, Mass., since 1891, died at his home in that city Jan. 10 after a two months' illness from Bright's disease and heart failure. Mr. Cook studied at the Massachusetts Institute of Technology, and later was in the office of Ernest W. Bowditch, Civil Engineer, of Boston, Mass. In 1889 he opened an office in Salem and was employed as an engineer on the Salem Water-Works. In 1891 he was elected Superintendent of the Water-Works, a position he held until his death. He was 46 years old.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 18 to 20, 1905. Annual meeting at Chicago, Ill. Secy., E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.
Jan. 23 to 25, 1905. Annual meeting at Columbus, O. Secy., E. G. Bradbury, Columbus, O.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24 to 26, 1905. Annual meeting at Montreal, P. Q. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal, P. Q.

STATE AND LOCAL BOARDS OF HEALTH OF OHIO.
Jan. 27, 28, 1905. Annual meeting at Columbus, O.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Jan. 30 to Feb. 11, 1905. Annual meeting at Birmingham, Ala.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 28, 1905. Annual meeting at Toronto, Ont. Secy., Killaly Gamble, Temple Bldg., Toronto.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.—A new society, under the above name, was organized in New York City a few weeks ago. Mr. J. E. Starr was elected President, and Messrs. D. C. Ball and H. B. Roelker, Vice-Presidents.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The next meeting of the society will be held at its quarters in Tremont Temple, Boston, Mass., on the evening of Jan. 25, 1905. Mr. I. E. Moultrop, of the Edison Electric Illuminating Co., will read an illustrated paper on "The Steam-Turbine Generating Station of the Edison Electric Illuminating Company at South Boston." Secy., S. E. Tinkham.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The monthly "reunions" at the society's house in New York City will be a feature of the present winter also, after being conducted very successfully for two seasons past. The dates for these reunions are the last Tuesdays of January, February, March and April. The first of these, on Jan. 31, will be addressed by Rear-Admiral George W. Melville, on the subject, "Epochs in Marine Engineering." The meeting will begin at 8.15 p. m.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—At the first session of the annual meeting, which is in progress in New York City at the time of writing, the following officers were elected for the coming year: President, Prof. William Kent; Vice-Presidents, Messrs. R. P. Bolton and C. B. J. Snyder; Secretary, Mr. W. M. Mackay; Treasurer, Mr. U. G. Scollay; Governors, Messrs. B. H. Carpenter, B. F. Stangland, James Mackay, A. B. Franklin and J. C. Trachsel.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The next meeting of the Structural Section, which will also be the annual meeting of the section, will have two papers: "Methods of Expansion in Railway Bridges," by Frank Rice, and "Cushioned Roadbeds for Railroad Bridges," by E. K. Morse.

The Mechanical Section held its annual meeting on Jan. 3, 1905. Mr. H. H. Anderson was elected Chairman, Mr. W. H. Baltzell Vice-Chairman, and Mr. H. D. James Secretary. The next meeting of the section will be held on Feb. 7 at 8 p. m., when Mr. G. L. Luetscher will read a paper on "Open-Hearth Furnaces."

NEW ENGLAND WATER-WORKS ASSOCIATION.—The reports at the annual meeting of the association, held at Hotel Brunswick, Boston, Mass., on Jan. 11, showed a total membership of 604, and assets of $2,800. An Index to the Journal of the Association was gotten out during the year, which increased the total expenditures; however, the cost per member is lower than ever before. About 130 persons, among them nearly 50 ladies, were present at the meeting. Mr. Desmond FitzGerald presented a great number of views illustrating the Manila Water Supply, and accompanied them by an informal talk on the subject. Secy., Willard Kent, Narragansett Pier, R. I.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.—The annual meeting of the society was held at the Seattle (Wash.) Chamber of Commerce on Jan. 7, 1905. Officers were elected for the coming year as follows: President, Mr. F. W. Hibbs; Vice-Presidents, Messrs. J. D. Blackwell, T. A. Noble and A. H. Fuller; Secretary, Professor Milnor Roberts; Treasurer, Mr. H. W. Scott; Librarian, Mr. A. B. Coe; Directors, Messrs. W. D. Barkhuff, J. M. Clapp, J. J. Crydeman, J. L. McPherson, C. E. Fowler, I. C. Otis, W. R. Prowell and W. W. Cummings. After the election, Mr. F. R. Bates, of Seattle, read a paper entitled "General Notes on Electrical Machine Design."

ENGINEERS' CLUB OF PHILADELPHIA.—The annual meeting of the club will be held at its house on Jan. 21, 1905, at 8.15 p. m. Officers will be elected, reports submitted, and the address of the retiring president, Mr. Carl Hering, will be read. An exhibit of new apparatus, models, drawings, etc., in the club-house will be a feature of the meeting.

The report of the Board of Directors for the year shows a present membership of 496. The average attendance at each of the 18 meetings of the past year was 88, the maximum 155. The year's receipts and expenditures averaged about $7,000 each, and the present value of the club is about $6,250, of which some $2,000 is in cash.

BROOKLYN ENGINEERS' CLUB.—At the regular meeting of the club for January, held at the club rooms, 197 Montague St., Brooklyn, N. Y., on the evening of Jan. 12, a paper on "Floating Dry-Dock Construction" was read by Mr. Wm. T. Donnelly. It was illustrated by a large number of slides, showing drawings and views of early and modern floating dry-docks in the Port of New York. The floating dry-dock is generally held to be an American invention, and thus the earliest recorded (1816) dock of this kind, one of whose type was up to a few years ago in service at Hoboken, N. J., is probably the original of all floating dry-docks. It was in shape like a flat-bottomed hull with gates in the stern-wall, and rested on the bottom while in use, the water draining out as the tide went down. The successor of this dock, a structure nearly 100 ft. square in plan, was intended to be of similar type, but the unmanageable character of the closed box led to removing the ends, using the double bottom as air-space, and providing an auxiliary wedge-shaped air space in the wings, to aid against rolling. This, then, was the first real floating dock. A short time later the idea of using a sectional dock appeared (1837) as a solution of the problem of making the dock more readily controllable. From this first sectional dock, the development has been mainly one of refining the design and details. Mr. Donnelly then described in some detail the 10,000-ton sectional dock built by the Tietjen & Lang Co., of Hoboken, N. J., a few years ago, and illustrated in a full article in Engineering News of May 2, 1901 (p. 314). This is a sectional dock. A solid (one-section) dock of 1,000 tons capacity is also in service at Hoboken, and a 3,500-ton sectional dock is now being built there. These docks are all of timber, according to Mr. Donnelly's preference, but in discussion the wide use of steel sectional docks was noted, and a few words said in favor of steel for this service. The discussion also brought some arguments in defense of fixed dry-docks, as giving a rigid and unyielding support to the vessel during the time in dock. Naval Constructor W. J. Baxter summarized this opinion by saying that he would use a fixed dock whenever he could get it, and would be very glad to use a floating dock when one of the fixed type is impossible. Secy., J. Strachan, 197 Montague St., Brooklyn, N. Y.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—The second annual dinner of this association was held at the Hotel Vendome on the evening of Jan. 12. The number present exceeded 150. The President of the Association, Mr. Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment of New York City, acted as master of ceremonies, with President Cromwell, of the Borough of Richmond, and Mr. Calvin Tomkins, President of the Municipal Art Society, on his right and left. In the speeches made after the dinner President Cromwell described the engineering and other developments in progress on Staten Island while Mr. Tomkins urged that the Municipal Engineers should cooperate with and supplement the work of the Municipal Art Society, advising especially that attention be given to the development of a general plan for city improvement.

The other speakers included Messrs. John F. O'Rourke, J. V. Davies, J. C. Meem and Charles Whiting Baker. A notable feature of the evening was the presence at the guest's table of the venerable Chas. H. Haswell, now nearly 96 years of age. Our readers will recall the portrait and biography of this distinguished old engineer in our issue of June 2 last. Mr. Haswell still regularly performs daily work in the Municipal engineering service at the desk and drawing board, and appears in excellent general health and spirits. Although it was 1 a. m. when the speechmaking was concluded and the party broke up, Mr. Haswell remained till the close, seeming unwearied by the lateness of the hour.

When called upon by the toastmaster, Mr. Haswell responded with some excellent stories and anecdotes, relating among others that he well remembered as a youth talking with men who were members of the party which threw the tea overboard in Boston Harbor in pre-Revolutionary days. One of these men, who was also a "Minute Man" of the Revolution and participated in the battles of Lexington and Bunker Hill and who at the battle of Trenton aided in carrying Lafayette off the field after he was wounded, taught young Haswell the original version of "Yankee Doodle," which Mr. Haswell repeated to the guests, as follows:

"Father and I went down to camp,
Along with Captain Goodwin,
And there we saw the men and boys
As thick as hasty pudding.

There they had an iron gun,
As big as a log of maple,
Mounted on a little cart,
A load for father's cattle.

And every time they fired it off,
It took a horn of powder.
It went something like father's gun,
Only a nation louder.

Cornstalks twist your hair,
Cart wheels around you,
Great dragons swallow you up,
And mortar and pestle pound you."